MECHANICAL ENGINEERING

June, 1958

Review of Heat Transfer Literature—1957

Engineering Research With a Solar Furnace

Airsprings Cushion the Ride

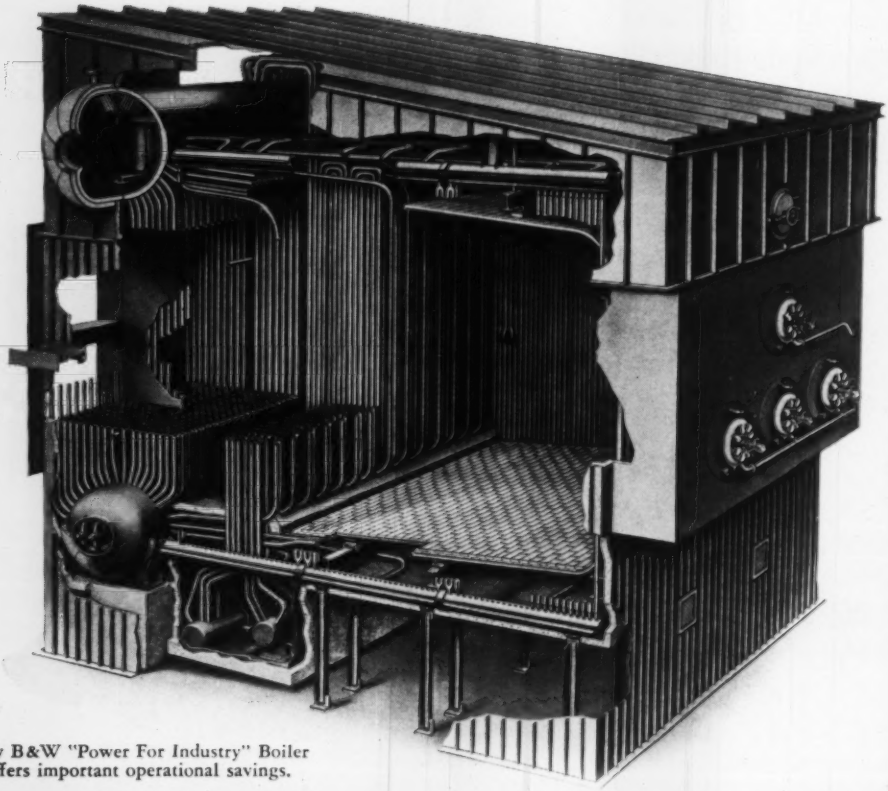
Progressive Mechanization

Flight-Control Linkages

Measuring Human Effort

Gas Cleaning

Steel for The Thermal Thicket



New B&W "Power For Industry" Boiler offers important operational savings.

New Economical Power For Industry

B&W "PFI" Oil-Gas Burning Boiler Provides Maximum Output in Minimum Space

Here's an answer to industry's need for an economical, dependable steam supply. The new B&W Integral-Furnace Boiler produces high-quality, dependable steam economically at all ratings. Aptly named the PFI, the "Power For Industry" Boiler is compact, easy to install, quick to meet rapid and wide load swings. The new boiler gives long, sustained operation, requires little attention and is readily accessible for inspection, cleaning and maintenance.

Here are eight ways in which the PFI Boiler can be of benefit to you:

1. It requires a minimum amount of space for a given power output.
2. The pressurized furnace design assures economy by eliminating the induced draft fan and air infiltration. This means savings in cost of fans, fuel, and operating power.
3. Pre-assembly of many of the components of the PFI Boiler is controlled in B&W shops, resulting in a reduction of the time and manpower required for field erection.
4. The PFI is designed to burn oil, gas, or a combination of the two. When it is equipped with a dual-fuel burner, it allows you to take advantage of favorable market conditions.
5. Cyclone Steam Separators insure adequate water circulation which protects boiler tubes from overheating, even with wide and frequent changes in load. They also give you clean, dry steam at all designed ratings with high boiler water concentrations.
6. The drainable superheater design assures quick, safe start-up and ease of storage.
7. Water-Cooled Burner Throat eliminates troublesome maintenance, costly repairs.
8. All-Welded Membrane Wall contributes to high efficiency and reduces insulation requirements.

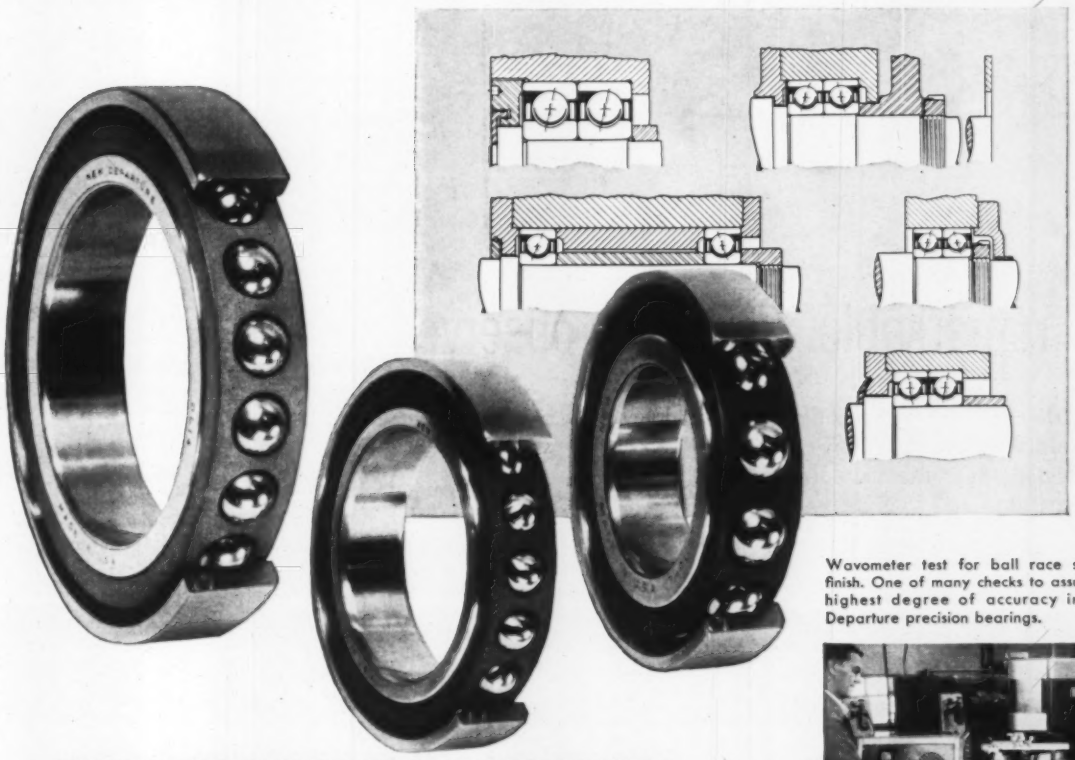
B&W has placed over 4,000 Integral-Furnace Boilers of various types in service over the past 25 years alone. This experience is your assurance of quality. For further information, write for Bulletin G-94. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-892A-IF

BABCOCK & WILCOX

BOILER DIVISION

ND FACTS



Wavometer test for ball race surface finish. One of many checks to assure the highest degree of accuracy in New Departure precision bearings.

Checking bearing face flushness under axial loads.

FOR PRECISION LOCATION... PLUS WIDE ADAPTABILITY

NEW DEPARTURE BALL BEARINGS

New Departure angular contact ball bearings are available in a full range of Extra-Light, Light and Medium Series, to all precision specifications. They give the designer a wide variety of bore, outside diameter and width relationships and mounting methods.

Made to light, medium and heavy preloads, and ground for universal mounting in any of the duplex arrangements or separated by spacers of equal length, they assure exact location of shafts or spindles under load conditions of every kind.

For full information, send for free booklets BA and DD on design and application.

1908–1958
GM
FORWARD FROM FIFTY

NEW DEPARTURE
DIVISION OF GENERAL MOTORS, BRISTOL, CONN.
NOTHING ROLLS LIKE A BALL

1948—*Early "point contact" transistor.*

The remarkable transistor observes its 10th birthday

In 1948, Bell Telephone Laboratories announced the invention of the transistor. In 1958, the transistor provided the radio voice for the first United States satellite.

To advance the transistor to its high level of usefulness, Bell Labs had solved problems which, in themselves, approached the invention of the transistor itself in scientific achievement.

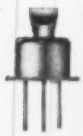
First, there had to be germanium of flawless structure and unprecedented purity. This was obtained by growing large single crystals—and creating the "zone refining" technique to purify them to one harmful part in *ten billion.*

The "junction" transistor, another radical advance, spurred transistor use. Easier to design, lower in noise, higher in gain and efficiency, it became the heart of the new electronics.

An ingenious technique for diffusing a microscopically thin layer on semiconductors was created. The resulting "diffused base" transistor, a versatile broadband amplifier, made possible the wide use of transistorized circuits in telephony, FM, TV, computers and missiles.

In telephony the transistor began its career in the Direct Distance Dialing system which sends called telephone numbers from one exchange to another.

For Bell System communications, the transistor has made possible advances which would have been impossible or impractical a brief decade ago.



1958—*Satellite transistor, incorporating 10 years of Bell Labs research and development.*

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

MECHANICAL ENGINEERING

PUBLISHED BY
THE AMERICAN SOCIETY OF
MECHANICAL ENGINEERS

Contents

VOLUME 80 • NUMBER 6 • JUNE, 1958

EDITORIAL DEPARTMENT

OFFICERS OF THE ASME

PUBLICATIONS COMMITTEE

REGIONAL ADVISORY BOARD

THE COVER

Steel for the hot airplane. At Ryan Aeronautical Company, San Diego, Calif., they fabricate heat-resistant, stainless steel into a strong, light structure which won the 1958 competition sponsored annually by "Materials In Design Engineering." Corrugated and flat sheets of paper-thin Armco Steel alloy combine into a structure that will form the skins of tomorrow's 15,000-mph vehicles.

FLIGHT-CONTROL LINKAGES ..... R. L. Roemer 56

Boosters? Power systems? You've still got to transmit motion, starting at the cockpit and ending at the control surfaces. The mechanical linkage is carefully engineered at Grumman.

AIRSPRINGS CUSHION THE RIDE ..... H. H. Deist 61

The new suspension. From Firestone, a briefing on low-frequency airsprings. To match them, steel springs would need many times the amplitude. And then there's the levelizing feature.

HEAT TRANSFER LITERATURE—1957
..... E. R. G. Eckert, J. P. Hartnett, T. F. Irvine, Jr. 64

Rockets, nuclear power, and novel industrial processes call for new mastery of heat transfer, new solutions. Here is a guide to the year's significant books and papers in this critical field.

PROGRESSIVE MECHANIZATION ..... A. J. Dunkle 76

How far does it pay to mechanize? As capital investment rises, so does maintenance. So does "unit burden," an elusive figure. AC Spark Plug reports an economic-justification study.

ENGINEERING RESEARCH WITH A
SOLAR FURNACE ..... P. E. Glaser 78

The idea: Heat transmission by radiation only. No conduction, no convection—and no contamination. Materials can be tested in a controlled atmosphere. Instruments can be brought close.

MEASURING HUMAN EFFORT ..... Lucien Brouha 81

Certain of your men may be working beyond their strength. It happens. At du Pont's Haskell Laboratory they've recorded heartbeats—a study of effort, recovery rate, cumulative fatigue.

GAS CLEANING ..... R. V. Kleinschmidt 84

How do you remove impurities from a gas? How effective are the methods, and how do you select and apply the right one? A consulting engineer presents the basic principles of gas cleaning.

Contents continued on following page

"B&W extrusions

simplify our production problems

We can reduce final parts cost through the use of a B&W Extrusion because it cuts machining time and eliminates waste of costly material."

Machining is expensive and wastes material. It is doubly so when it is not necessary. Design engineers should investigate the possibility of using an extruded section as starting material, particularly if expensive or difficult to machine materials such as alloy or stainless steels are involved. In many cases, by using a B&W Extrusion, parts production can be reduced to a mere cutting to length and a few simple finishing operations.

To find out more about how B&W Extrusions can help you design a better product at a lower cost call on any of the local sales offices of B&W's Tubular Products Division or write for a copy of Bulletin TB 413. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

TUBULAR PRODUCTS DIVISION

TA-8027-E1

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals.

MECHANICAL ENGINEERING

PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ADVERTISING DEPARTMENT

Publications Business Manager,
S. A. TUCKER

Advertising Manager,
C. R. TUNISON

Promotion Manager,
W. S. LANGER

Sales Representatives,
WILLIAM LAURIE
29 West 39th Street,
New York 18, N. Y.

GLENN EDDY
84 East Randolph Street,
Chicago 1, Ill.

JOHN E. OATE, JR.
Oliver Building,
Pittsburgh 22, Pa.

DILLENBECK-GALAVAN INC.
266 South Alexandria Avenue,
Los Angeles, Calif.

FRED W. SMITH & ASSOCIATES
1201 Forest View Lane, Vesthaven,
Birmingham 9, Ala.

Business Manager,
M. H. MARTY

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Mechaneer," New York. Price to members annually $3.50 for initial membership subscription, $5.60 for additional subscriptions; single copy 50 cents; to nonmembers annually $7.00, single copy 75 cents. Add $1.50 for postage to all countries outside the United States, Canada, and the Pan American Union. Changes of address must be received at Society headquarters seven weeks before they are to be effective on the mailing list. Please send old as well as new address . . . By-Laws: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4) . . . Second-class mail privileges authorized at Easton, Penna. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921.
©Copyrighted, 1958, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulation. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author and that date of publication be stated.

59,000 copies of this issue printed

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.

Contents (continued)

VOLUME 80 • NUMBER 6 • JUNE, 1958

Departments

EDITORIAL 55

BRIEFING THE RECORD 87

Turbo-Tug 87
Linden Generating Station 88
Boiler for Low-Volatile "Char" 89
Muffler Eliminates Noxious Fumes 90
Solar-Heated Homes 90
Controlling Production 91
Wood Products of the Future 91
92 Germanium Resistance Thermometer
92 Gangsaw on Wheels
93 Machine Abstracts
93 Precision Flame Cutting
94 Nuclear Briefs
94 Fermi Reactor Vessel Shipped
94 Materials Briefs

PHOTO BRIEFS 96

Fuel Cell 96
Sniffer 96
Smooth Weld Inside 96
Missile Dummy 96
96 Expansion Joints
96 Largest Solar Furnace
96 Water-Resistant Insulation
96 Clear Plastic Walls

EUROPEAN SURVEY 98

Rolling Tester for Gears 98
The Swiss Industries Fair 98
99 Railway Development in France
99 Lightweight Diesel Railcar

ASME TECHNICAL DIGEST 100

Gas Turbine Power 100
Lubrication 104
Hydraulics 105
Maintenance and Plant Engineering 106
Instruments and Regulators 107
Wood Industries 107
108 Aviation
111 Power
112 Management
112 Machine Design
113 Availability List of Unpublished ASME Papers
113 ASME Transactions for May, 1958

COMMENTS ON PAPERS 114

REVIEWS OF BOOKS 117

BOOKS RECEIVED IN LIBRARY 118

ASME BOILER AND PRESSURE VESSEL CODE 118

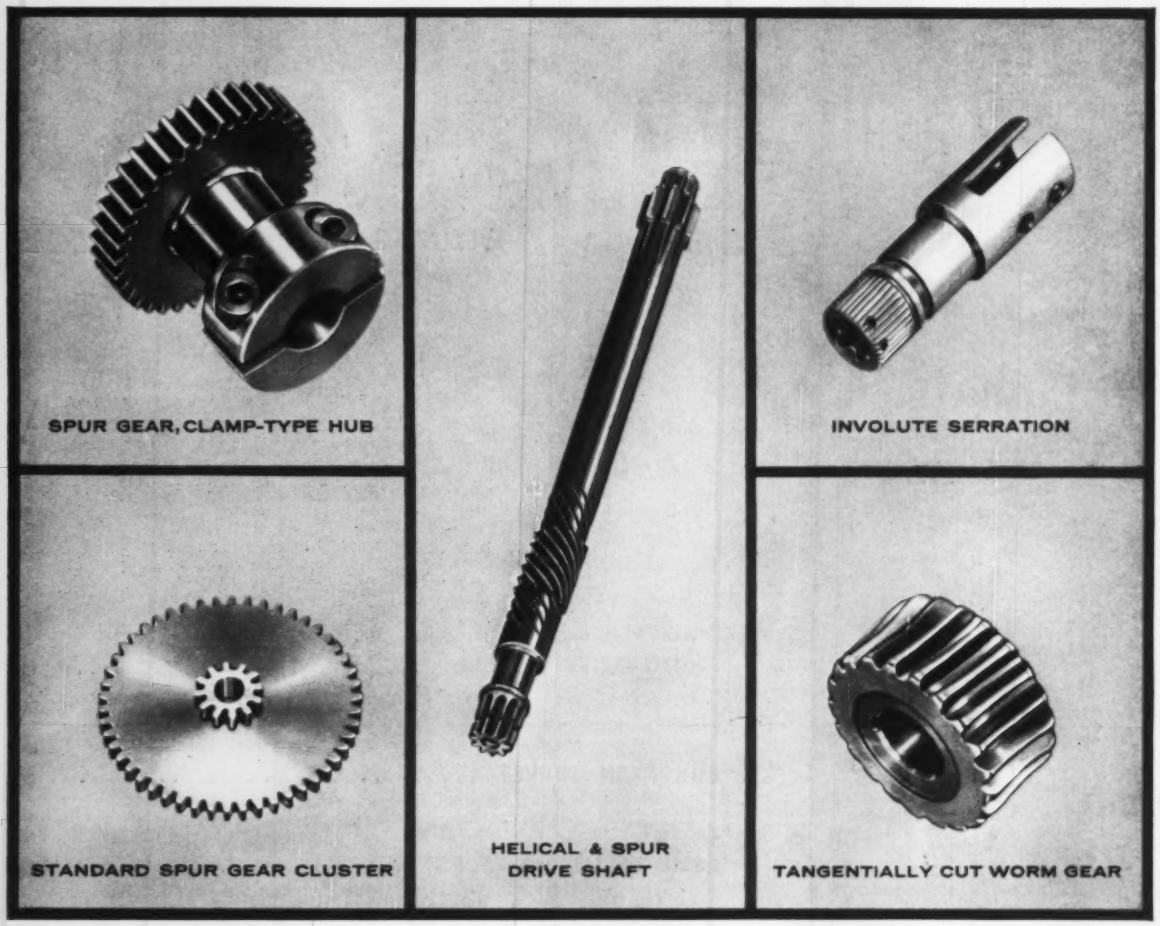
THE ROUNDUP 123

That Ivory Tower 123
AEC Submits Papers for Geneva UN Conference 124
United Engineering Center 124
Meetings of Other Societies 126
126 U. S. Applied Mechanics Congress
126 Teachers Needed to Train Engineers
126 Education

THE ASME NEWS 128

CONFERENCES
Instruments and Regulators 130
Automatic Techniques 133
Production Engineering 134
Design Engineering 136
Metals Engineering 138
Railroad 140
Maintenance and Plant Engineering 142
Management 144
ASME To Split Transactions 128
Admiral Rickover Scores School Equality 128
132 ASME Host to Soviet Engineers
135 ASME Coming Events
145 ASME Elects Fellows
147 People
148 Junior Forum
150 23rd Power Show
150 ASME Standards Workshop
151 ASME Executive Committee Actions
152 Jobs
154 Candidates
156 Obituaries

KEEP INFORMED 161
CLASSIFIED ADS 233
240 ..... CONSULTANTS
242 ..... ADVERTISING INDEX



SEND FOR G.S. *technical data, free! See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. Folder contains 23 pictures of Small Gears, plant view, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!*

FRACTIONAL HORSEPOWER GEARING

GEAR Specialties, Inc.

2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS

SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARING

an important G.S. specialty: CUSTOM HOBBING!

You see here only a few of the many, many applications of the hobbing process which G.S. performs so expertly, either manufacturing complete or cutting on furnished blanks. Whether in the medium-coarse or fine pitch ranges, we handle the simpler designs by the hundreds or the thousands — and of course, with that famous G.S. constant-quality precision which assures you of smoother production and better product performance. But we take highly specialized and complex designs in stride, too — with 42 G.S. years of top-flight experience backing up our unsurpassed production facilities, we can help in developing just the *right* way to do your unusual job.

If you are getting ready to launch new items or models — or if you are revamping present lines for greater efficiency and lower costs—call G.S. in to help. All we know about Small and Intermediate Gearing (and that's a lot, if we do say so!) is at your service. Why not a letter or a phone call today?

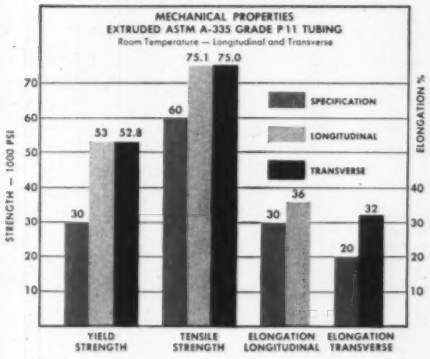
42 Years of Specializing in Small Gearing!

EXTRUSION • CASTING • FORGING • FABRICATION

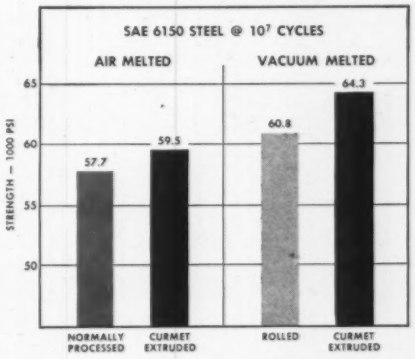
CURMET

Ferrous, non-ferrous and titanium alloys give you the properties you need for positive performance.

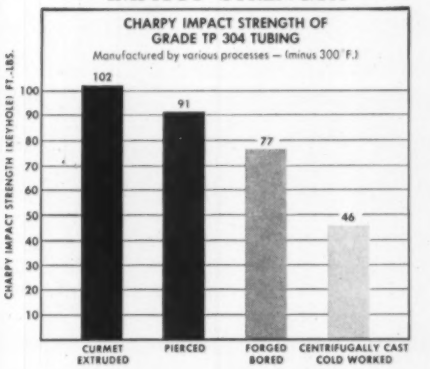
TRANSVERSE STRENGTH



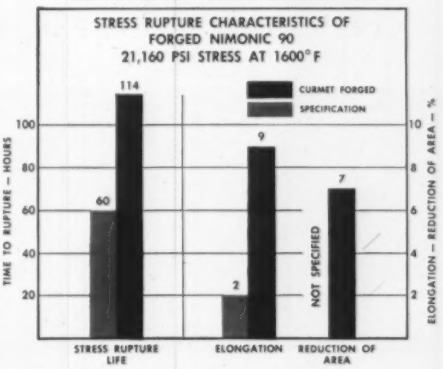
TORSIONAL FATIGUE



IMPACT STRENGTH



ELEVATED TEMPERATURE

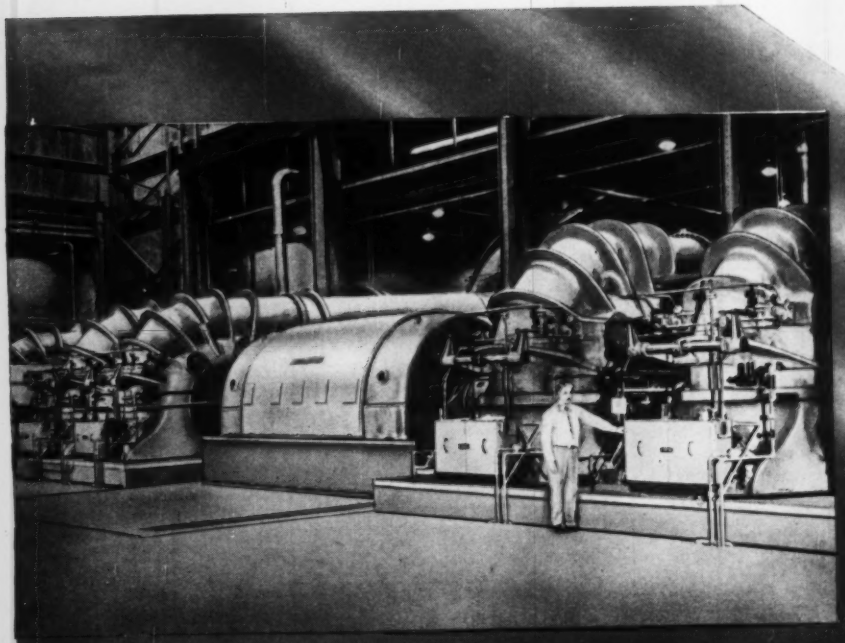


Above are examples of physical properties resulting from CURMET Processing. Consult CURMET for data to meet your design problems. CURMET Processing has been developed by the Metals Processing Division of the Curtiss-Wright Corporation.

FOR FULL INFORMATION, WRITE TO:

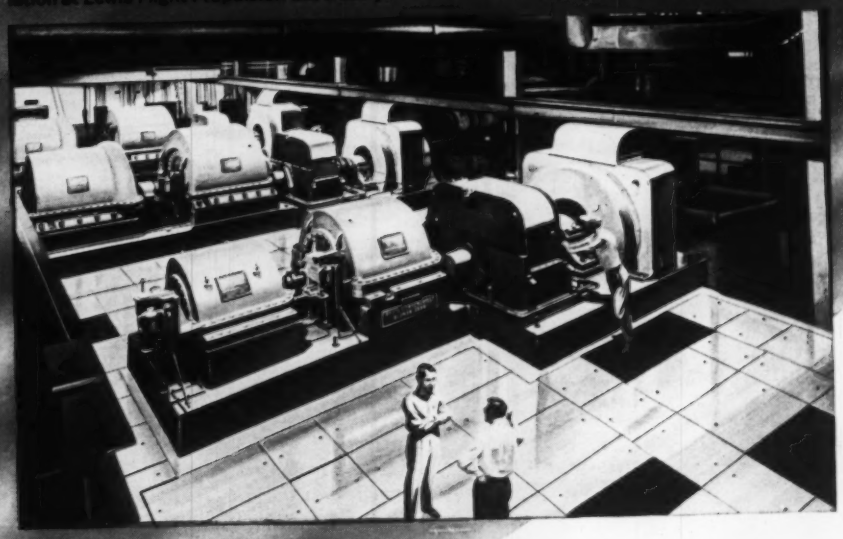
METALS PROCESSING DIVISION
760 Northland Avenue

CURTISS-WRIGHT CORPORATION
Buffalo 15, New York



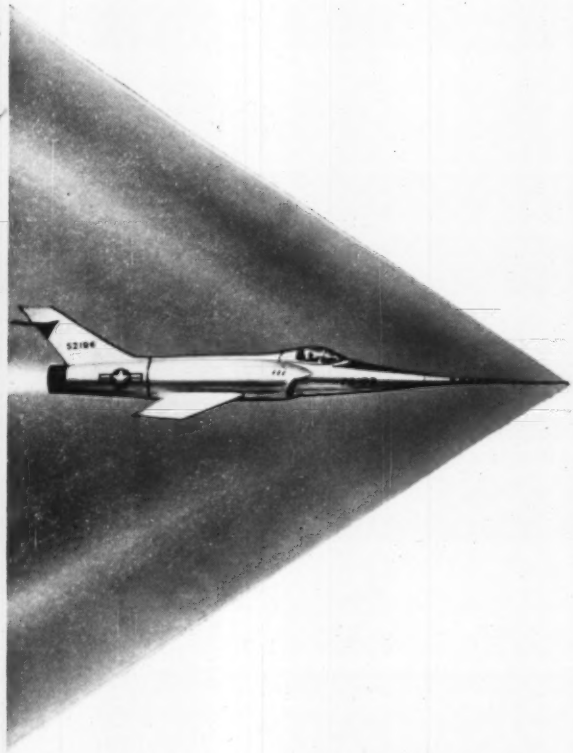
Five R-C single-stage centrifugal blowers developing over 1,000,000 cfm direct driven from electric motors rated at more than 80,000 HP at Langley Field, Virginia.

Six R-C multi-stage blowers rated over 75,000 cfm requiring about 14,000 HP, part of a centrifugal installation at Lewis Flight Propulsion Laboratory in Cleveland.



Roots-Connersville creates

STOP-AND-GO WHIRLWINDS FOR AIRCRAFT RESEARCH



Man-made air masses that match the violence of nature's hurricanes pour from the Roots-Connersville Blowers at the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics. Yet the power of these huge wind-making machines can be instantly controlled, from a soft, whispering breeze to a roaring, whirling cyclone. In the reverse, the siphoning air movement can develop almost perfect vacuums to simulate the air conditions of high altitudes. A similar but larger N.A.C.A. "wind-making system" is now completed at Langley Field, Virginia.

The same engineering and manufacturing abilities that developed these stop-and-go whirlwinds are applied by Roots-Connersville to the everyday movement of gas and air, in small or large quantities, for industry. Now in its second century of service, Roots-Connersville Blower Division, one of the Dresser Industries, builds the world's most extensive and varied line of such equipment.

Teamwork...that serves the world!

In its specialized field, each Dresser company, operating independently, has the experience, facilities and engineering manpower to meet the progressive needs of the industries it serves. Whenever an unusually challenging problem is put before any Dresser operating unit, the vast research, engineering and production facilities of all divisions of Dresser Industries, Inc. can be swiftly mobilized into effective teamwork. Throughout the oil, gas, chemical, electronic and other industries, this coordinated performance is known as the Dresser *Plus*+... a standard of comparison the world over. *Briefacts* gives the complete story of the Dresser *Plus*+. Write for your copy today.

Tomorrow's progress planned today

DRESSER INDUSTRIES, INC.

EQUIPMENT AND TECHNICAL SERVICES

OIL • GAS
CHEMICAL
ELECTRONIC
INDUSTRIAL

REPUBLIC NATIONAL BANK BUILDING, DALLAS, TEXAS

These are the Dresser Industries:

CLARK BROS. CO.—*compressors & gas turbines* + **DRESSER-IDECO COMPANY**—*steel structures* + **DRESSER MANUFACTURING DIVISION** — *couplings* + **THE GUIBERSON CORPORATION** — *oil tools* + **IDECO, INC.** — *drilling rigs* + **LANE-WELLS COMPANY** — *technical oilfield services* + **MAGNET COVE BARIUM CORPORATION**—*drilling muds* + **PACIFIC PUMPS, INC.**—*pumps* + **ROOTS-CONNERSVILLE BLOWER DIVISION** — *blowers and meters* + **SECURITY ENGINEERING DIVISION** — *drilling bits* + **SOUTHWESTERN INDUSTRIAL ELECTRONICS** — *electronic instrumentation* + **WELL SURVEYS, INC.** — *nuclear & electronic research & development.*

Impact resistance—The image of impact can take many forms. To a train-conscious youngster, impact might be the crash-coupling of freight cars. To the contour miner, impact is a mammoth dipper smashing into frozen highwall. To the ordnance man, impact is a shell striking armor plate. Whatever the image, impact implies one thing—toughness.

Toughness is the ability to absorb energy—to "give" under a shock load without fracturing. This property—toughness—in steel, more than in any other material, has been vital to the building of the modern world. Steel's ubiquitous role, however, belies the complexity of toughness. Because just as there are many kinds of steel, so there are many degrees of toughness, and a given steel's toughness is shaped by the admixture of its composition, manufacture and fabrication.

The design engineer, if he is to do his job well, must know his toughness in order to select the right steel for the job. He must know something of how toughness is achieved, because this often can result in using less expensive steels. The geometry of a part or structure is also important to its toughness, and here the designer reigns supreme.

In steelmaking, toughness and strength are determined by composition and manufacturing steps. Often, as is the case with USS* "T-1" Constructional Alloy Steel, a very high level of strength and toughness is obtained through selection of alloying elements and by proper heat treatment. The steelmaker can help you obtain the best combination of strength and toughness along with other desirable properties like weldability, corrosion resistance, formability and wear resistance. He can also recommend post-fabrication heat-treating practice where it is required to develop mechanical properties or relieve stress in fabricated assemblies.

Clearly, toughness is complex. But for any application, there is one best steel no matter what combination of properties you need. You are almost certain to find that steel among the great family of USS Design Steels: Carbon, High Strength, Alloy and Stainless. Our experience is yours for the asking. Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. You'll find our nearest representative in the Yellow Pages listed under United States Steel.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS *TRADEMARK

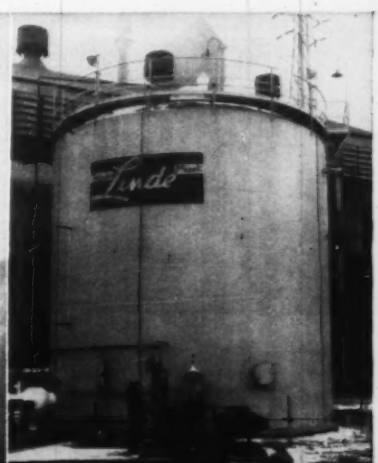
United States Steel

STEELS FOR DESIGN

Lower Left—Problem: Design dump cars for tunnel excavations to remove rock. Must have high impact resistance, plus corrosion resistance to withstand alternate wetting and drying. Solution: Build cars from USS COR-TEN* High Strength Steel. Pay-off: Cars take minimum maintenance, have been in continual service for six years, and are still in excellent condition.

Lower Middle—Problem: Design a 60 cu. yd. shovel that could take the terrific abuse of all-weather overburden removal. Solution: Bucket, bail, dipper stick and crowd rack built entirely of welded USS "T-1"* Steel, a constructional alloy steel having exceptional toughness at below zero temperature and which can be field-welded and flame-cut. Pay-off: Outstanding performance in 7-day-a-week, 24-hour-a-day service with minimum maintenance.

Lower Right— Problem: Design a tank to hold the liquid equivalent of 10 million cubic feet of oxygen at 300°F. below zero. Solution: Tank was designed with impact-resistant austenitic USS Stainless Steel. Pay-off: Tank can withstand sudden changes of pressure, temperature changes and volume at low temperatures that would shatter other materials.

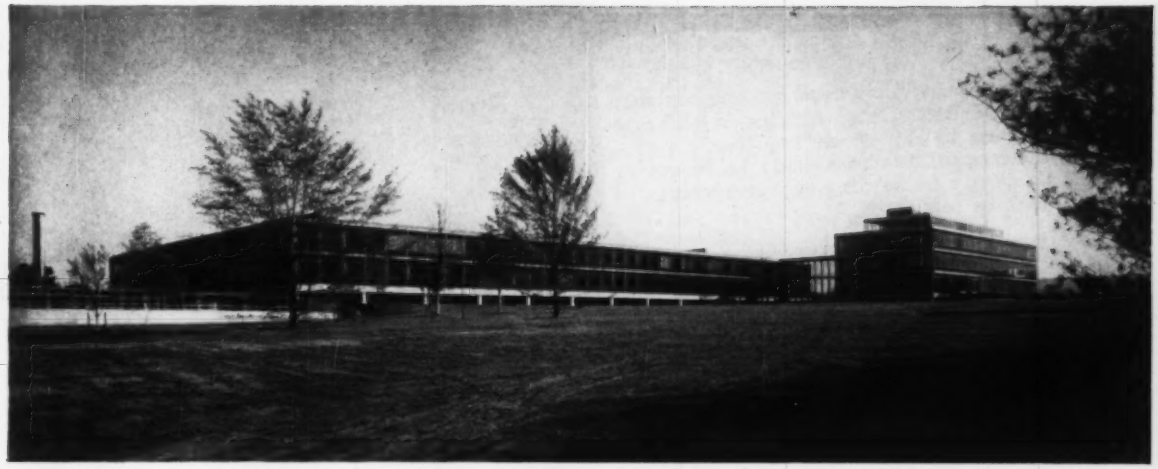


WICKES TYPE S-1AL

HEAT ONE OF AMERICA'S

STEAM GENERATORS

MOST MODERN BUILDINGS



CONNECTICUT GENERAL LIFE INSURANCE CO., Bloomfield, Conn.

ARCHITECTS:
Skidmore, Owings & Merrill

GENERAL CONTRACTOR:
Turner Construction Co.

MECHANICAL CONTRACTOR:
Kerby Saunders, Inc.

A recent exhibit at the National Gallery features 10 of America's most modern buildings. The American Institute of Architects, on the occasion of its Centennial, included in the exhibit the new home office of the Connecticut General Life Insurance Company in suburban Hartford, which is equipped with Wickes boilers. This spacious, sun-flooded building of steel and glass, is nearly a modern city in itself, for it houses not only the complete office system, but includes employee lounges, game rooms, medical department, mailrooms, auditorium, bowling alleys, barber and beauty shops as well.

For the heating system in this mammoth structure, engineers chose to install two Wickes type S-1AL steam generators equipped with both oil and gas burners. In addition to general heating, the steam generators provide power to operate the refrigeration machines and a snow-melting system on the truck ramp. The boilers each have 3700 sq. ft. of heating surface, and were designed for a maximum continuous load of 27,500 pounds of steam per hour at 200 PSIG.

Bulletin No. 55-1 gives complete facts on Wickes products. New engineering bulletins on Type-S and Type-A Steam Generators are also available on request.

WICKES

WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 • SALES OFFICES: Boston • Chicago • Cleveland • Dallas • Denver • Detroit • Houston Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • New Orleans • Portland, Ore. • Saginaw San Francisco • Springfield, Ill. • Tulsa

144

rigid specifications

Tension tests are required to be made at room temperatures and at 670° F. The following minimum physical properties shall be met:

At Room Temperature:

TS	YS	EL	RA	CHARPY V-NOTCH
70,000	30,000	45	50	50

At 670° F. the minimum tensile strength shall be 51,000 p.s.i. and the minimum yield strength 18,300 p.s.i.

Rejection

Each casting that develops unacceptable defects during shop working or fails to conform to all of the requirements of these specifications shall be rejected. No repair by welding or other means will be permitted.

All cast pipe shall be hydrostatically tested to 5,900 p.s.i. and held at that pressure for 20 minutes with zero pipe leakage. Each length of pipe shall be hydrostatically tested at the manufacturer's plant.

Radiographic Inspection

(a) Paragraph S5 (a) of the Supplementary requirements of ASTM-A 362-52T.

(b) All castings shall be radiographed 100% and shall conform to ASTM-E7 1-52, Class 2 quality, except as modified by these specifications.

(c) The manufacturer shall establish a positive system of identification of the X-ray plates which shall be subject to approval by the inspector. This system shall guarantee complete coverage by radiographing and provide for positive identification between the plate and the subject.

Inspection of Penetrants

All castings shall be subjected to inspection by fluorescent penetrants or penetrating dyes both inside and out. All cracks, porosity, or flaws revealed as a result of the Dye Penetrant Test shall be due cause for rejection of the casting.

The 304L stainless steel shall conform to the following ladle analysis:

Carbon	.03 max.		
Manganese	1.50% max.		
Phosphorous	.03% max.		
Sulphur	.03% max.		
Silicon	2.00% max.		
Chromium	18.00	-	21.00%
Nickel	8.00	-	11.00%

Pipe: All pipe of the following sizes shall be centrifugally cast stainless steel as per ASTM-A 362-52T, except as modified by these specifications:

16" - Sch. #160
12" - Sch. #160
10" - Sch. #160
8" - Sch. #140

All pipe shall be machine finished to 125 micro-inch interior and exterior.

for nuclear piping met by U.S. PIPE metal mold process

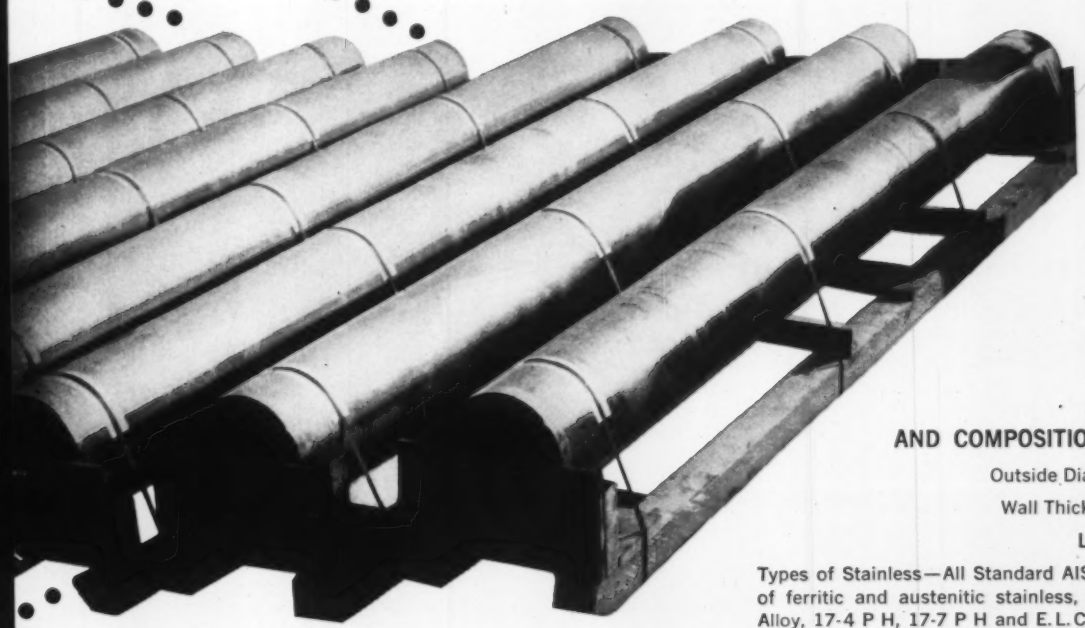
Centrifugally Cast Stainless Steel Solves Many Piping Problems

Combinations of temperatures, pressures and corrosive conditions never encountered before: these are among the piping problems that must be overcome by the men who design the nation's nuclear power installations.

Stainless steel centrifugally cast pipe provides many of the answers. Study the specifications at the left . . . specifications demanded of stainless steel pipe on a recent job for Paul Hardeman, Inc., Los Angeles, California. This pipe is being used for heavy duty, high pressure, elevated temperature service in the primary piping system of the SPERT-III Reactor at the U.S. Atomic Energy Commission's National Reactor Testing Station near Idaho Falls, Idaho. The Stearns-Roger Mfg. Company, Denver, Colorado, is the architect-engineer on this project. A complete tabulation of the actual test data obtained on this pipe and to this specification is available upon request.

U.S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses—in large and small quantities—and to individual specifications.

If piping of the type described above is the bottleneck in your nuclear power planning, write and outline the problem.



SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6" to 50"

Wall Thickness—⅜" and up

Length—Up to 16'

Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

BURLINGTON, NEW JERSEY

STEEL & TUBES U.S. PIPE DIVISION

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, PITTSBURGH, BIRMINGHAM, BURLINGTON

SAVE DRAFTING TIME WITH

CLEARPRINT® "FADE-OUT PRE-PRINT" FORMS

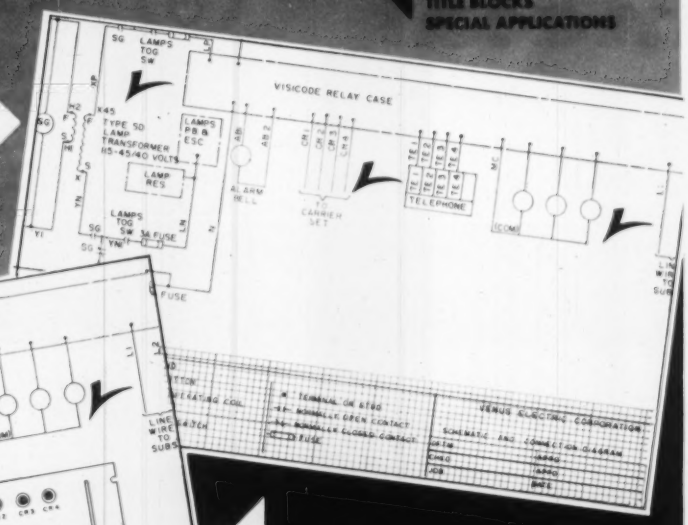
t.m. t.m.

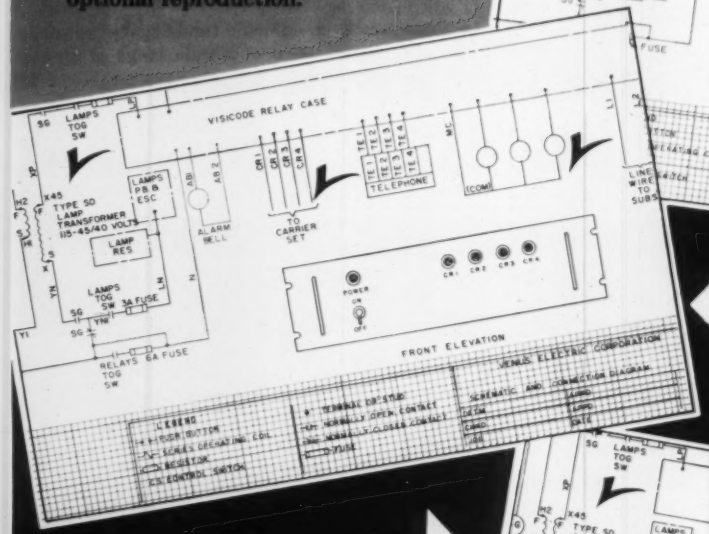
PRE-PRINTED

- TYPICAL DETAILS
- BASIC STANDARDS
- BILLS OF MATERIALS
- TITLE BLOCKS
- SPECIAL APPLICATIONS

Here Is Your Paper

Basic standards are pre-printed on your sheets in black for desired reproduction and in blue for optional reproduction.

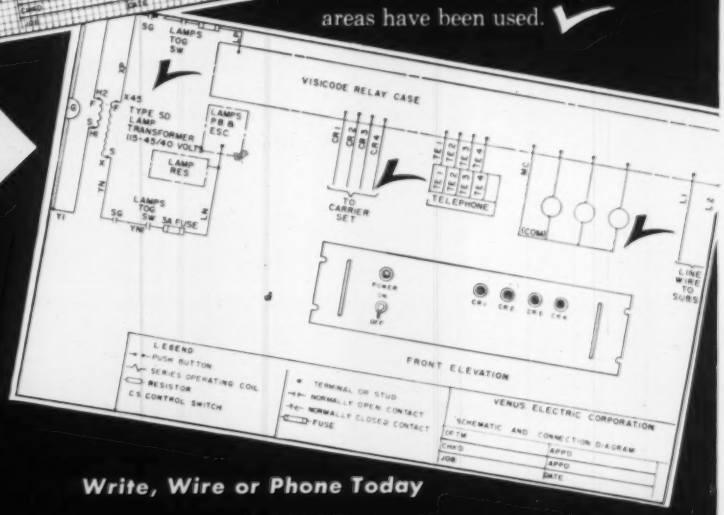




Here Is Your Finished Drawing

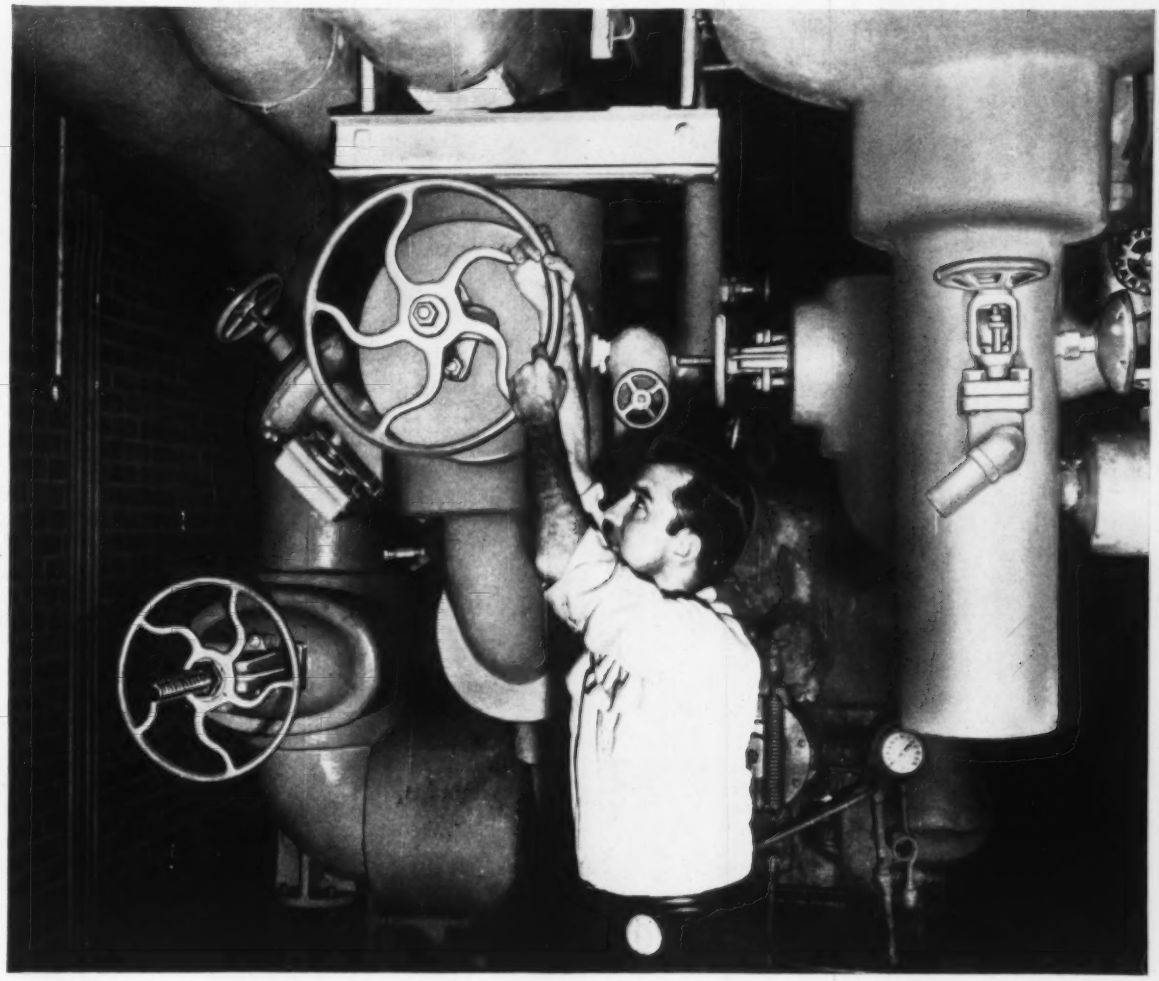
Quickly rendered to scale with accurate blue grid lines to guide you. Notice how the optional pre-print areas have been used.

Here Is Your Finished Print



Write, Wire or Phone Today

Cities Service shows how to cut valve costs



Crane globe valve in 14th year on steam turbine line

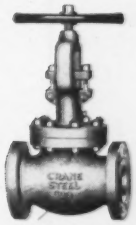
Cities Service Refining Corp. uses hundreds of valves at its Lake Charles, La., plant. Maintenance and replacement costs could be staggering, but for careful control of valve selection.

For example, the Crane 6-inch, 300-pound steel globe valve shown above was installed at the Lake Charles plant 14 years ago. Working at 250 psi., 600 deg. F., the valve is used in the steam line to a turbine-driven feed-water pump.

In spite of its operation 3 or 4 times a week, this sturdy Crane valve has continued tight in service and has required no repairs in 14 years!

Thrifty buyers want no better reward than the kind of cost-cutting, dependable service they get when Crane valves are installed.

That's why in the petroleum industry, as in all industries, you'll find more Crane valves used than any other make.

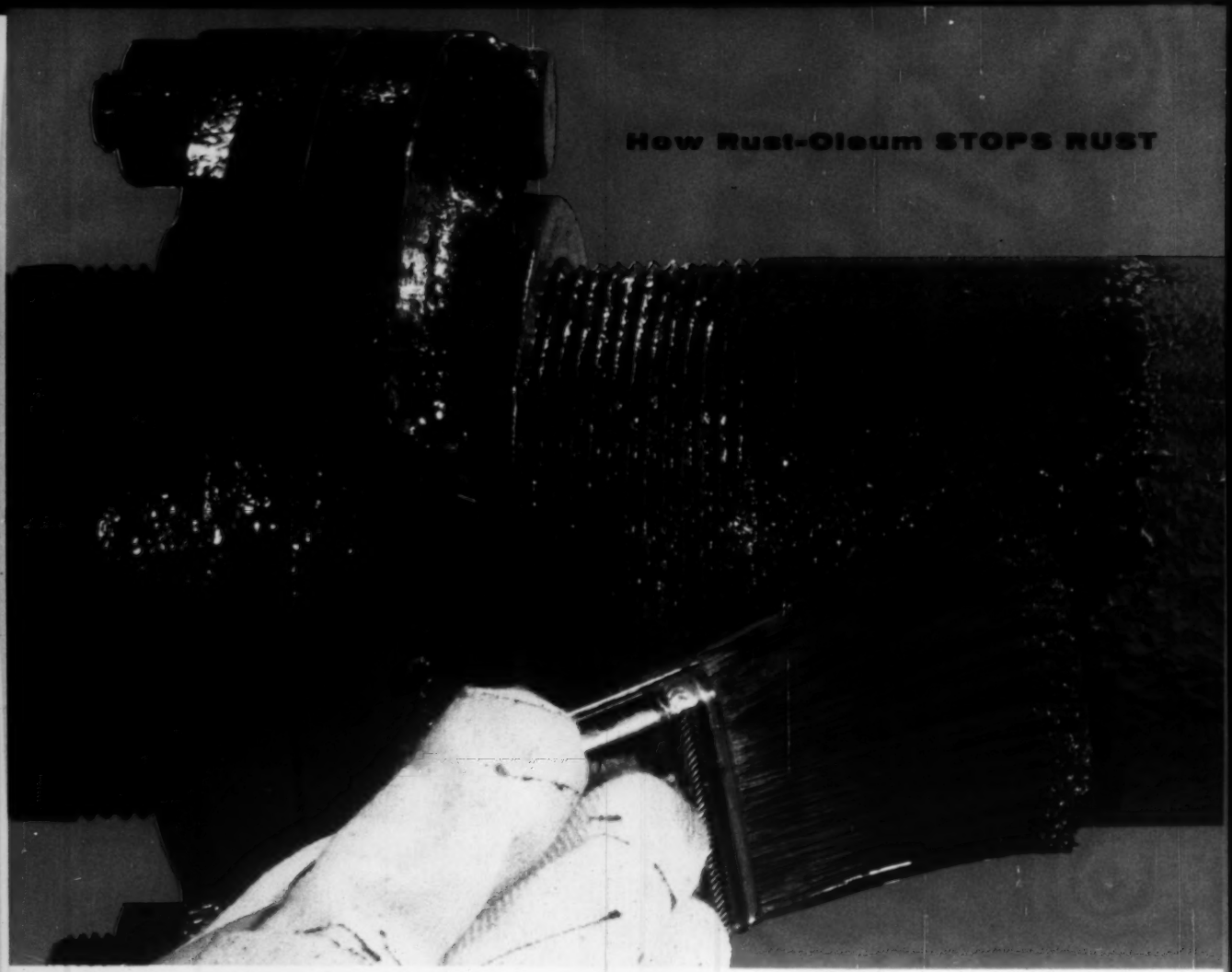


This is the valve used on installation above. CRANE 151XR, 300-pound cast steel globe valve for 850° F. maximum temp. Sizes: 2 in. to 8 in. For full details, see your Crane Representative, or write to address below.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

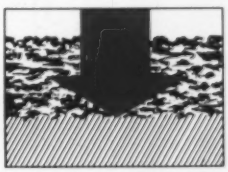
Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas



Helping to make present equipment last longer

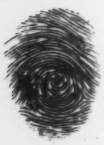
Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound rusted surface! Specially-processed fish oil vehicle penetrates rust to bare metal!

Cut costly surface preparations and save time, money, and metal by applying Rust-Oleum 769 Damp-Proof Red Primer over sound rusted surfaces after simple scraping and wirebrushing to remove rust scale and loose rust. You can do this because Rust-Oleum's *specially-processed* fish oil vehicle penetrates through the rust to bare metal, driving out air and moisture that cause rust. At the same time, it dries to a tough, durable surface coating that resists general weathering up to one year before applying the Rust-Oleum finish coat. See how Rust-Oleum can save you time, money, and metal. What Rust-Oleum has saved for others is not half so important as what it can do for you.



Write for special thirty-page report showing Rust-Oleum penetration through rust to bare metal as prepared by Battelle Memorial Institute Technologists.

RUST-OLEUM®

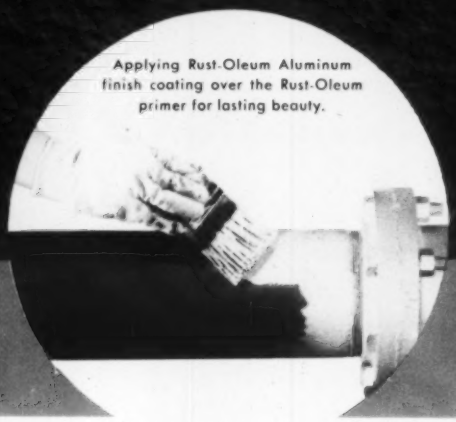


Distinctive as your own fingerprint.
Accept no substitute.

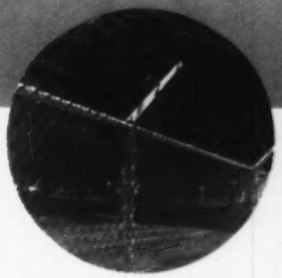
STOPS RUST!®

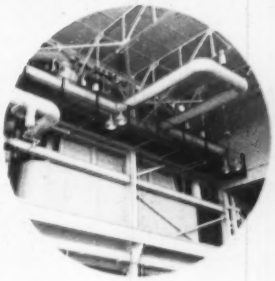
Prompt delivery
from Rust-Oleum
Industrial Distributor stocks.

and beautifies as it protects!



Applying Rust-Oleum Aluminum finish coating over the Rust-Oleum primer for lasting beauty.





Follow-up with the Rust-Oleum finish color of your choice for double protection and lasting beauty!

Stop Rust!—and do it in the color of your choice—that's step number two in the Rust-Oleum rust-prevention *system*. Simply apply the Rust-Oleum finish color over the 769 Damp-Proof Red Primer. You receive *double protection* and greater compatibility, because Rust-Oleum finish colors utilize the *specially-processed* fish oil vehicle—and they dry to a firm, decorative, high-gloss finish that resists sun, fumes, heat, moisture, weathering, salt air, etc. You *beautify as you protect*, because Rust-Oleum finish coatings are available in Aluminum, Black, Green, Yellow, Gray, Blue, White, Red and many others. Write for complete information with color charts. Specify Rust-Oleum for new construction, maintenance, and re-modeling. Rust-Oleum Industrial Distributors maintain complete stocks for your convenience . . . and will be happy to consult with you on your rust problems.

What is your rust problem? What Rust-Oleum color do you need?

White, Black, Aluminum, Gray, Green, Blue, Yellow, Red and many others—they're all yours with Rust-Oleum! Beauty that lasts over-the-years. Rust-Oleum is also available in custom formulations to match unusual colors or to meet unusual rust-producing conditions. Send us your rust problems. We'll send you complete details—no charge or obligation.

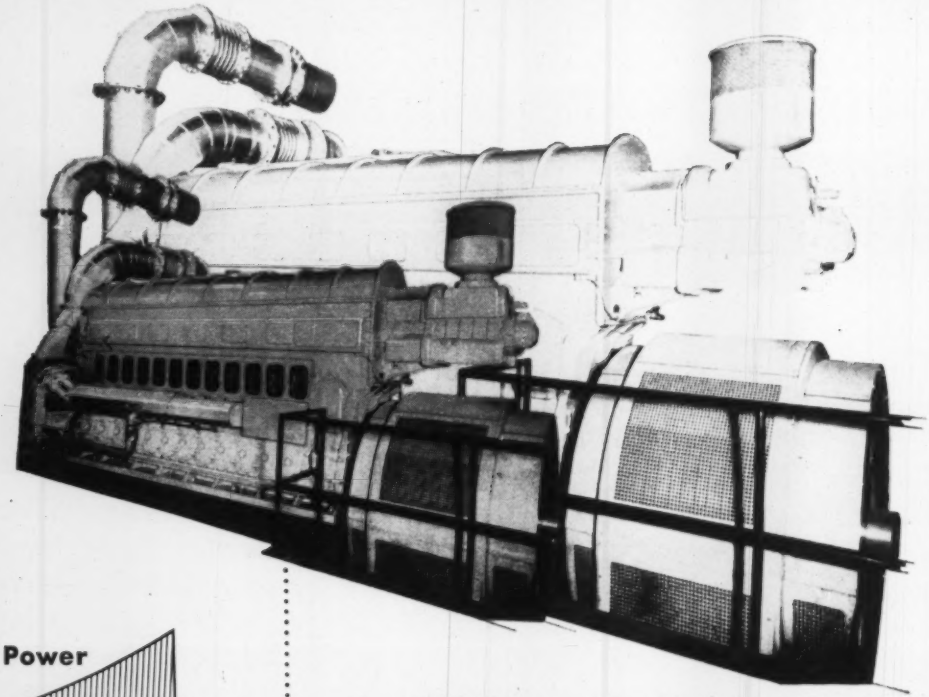
ATTACH TO YOUR LETTERHEAD FOR THE FACTS

Rust-Oleum Corporation
2990 Oakton Street • Evanston, Illinois

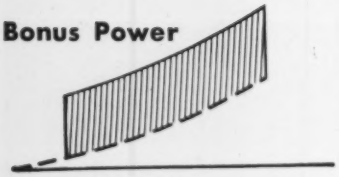
Please send me the following.

- ☐ Complete literature with applications and color charts.
- ☐ Information on matching special colors.
- ☐ Thirty-page report on Rust-Oleum penetration.

50% More Power with Fairbanks-Morse TURBOCHARGED OPPOSED-PISTON DIESEL

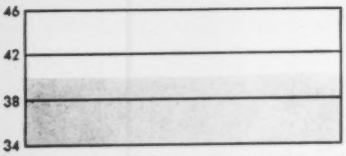


Bonus Power



Auxiliary blower is automatically declutched at loads above approximately 1/3 rating to deliver more usable power at the flywheel.

Increased Thermal Efficiency



Turbo-charged Fairbanks-Morse Model 38TD-8 1/8 Opposed Piston Diesel is approaching a new high of 40% efficiency.

New Efficiency...New Power...New Fuel Savings For Marine and Stationary Applications

The industry's most compact, simple, and dependable diesel—the Fairbanks-Morse Opposed Piston—*is now turbo-supercharged!* Fuel savings from 5% to 10% are effected on full-load operations—even more on part loads. And 50% more power has been added. At 900 rpm, for example, it is conservatively rated at 300 hp per cylinder. Yet it occupies virtually the same space as the non-supercharged version...weighs only about 8% more. Look at the advantages in this usually low size and weight per horsepower.

Stationary installations—save on foundation and building costs.
Commercial marine use—more power, speed, fuel and cargo capacity.
Portable operations—save with most compact power available today.

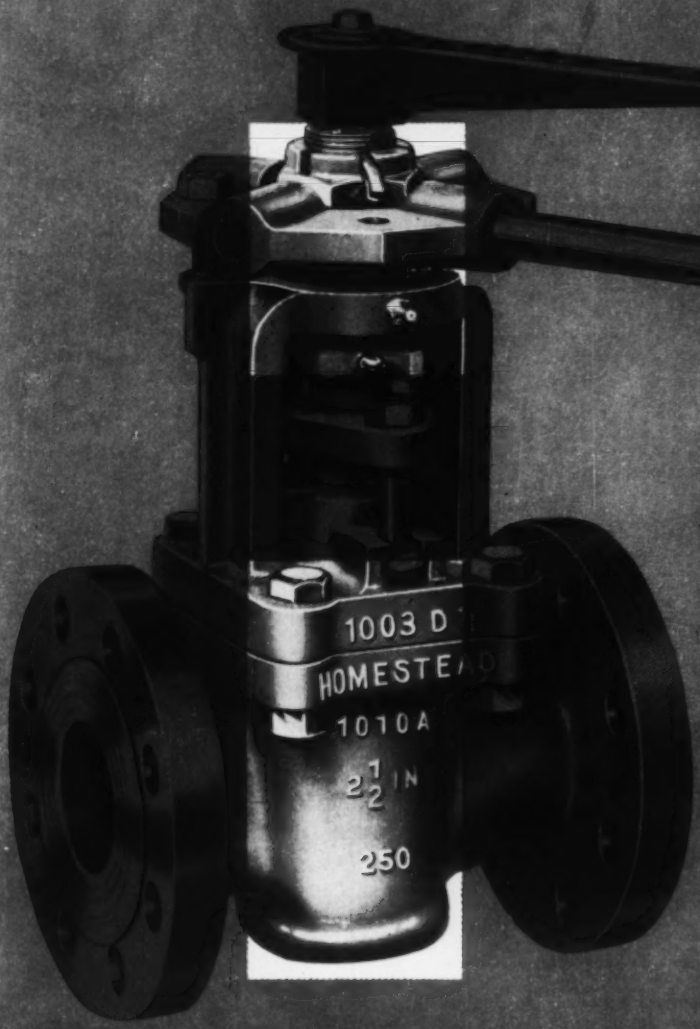
Greater power is available at higher altitudes because the engine is less sensitive to atmospheric pressure. Oil and water cooling requirements show almost no increase at the higher output. It's all possible with careful matching of system and engine. Divided manifolds permit use of exhaust pulses with no pressure cancellations. Engine-driven auxiliary blower provides scavenging air up to ⅓ load—declutches above this figure to make additional power available at flywheel. For full information write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

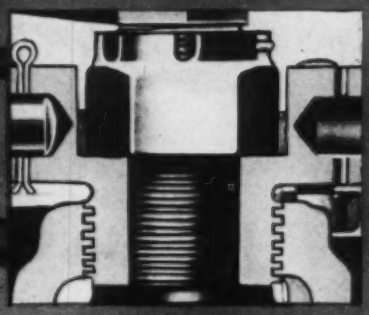
FAIRBANKS-MORSE
a name worth remembering when you want the BEST

DIESEL AND DUAL FUEL ENGINES
DIESEL LOCOMOTIVES • RAIL CARS
ELECTRICAL MACHINERY • PUMPS
SCALES • HOME WATER SERVICE
EQUIPMENT • MAGNETOS

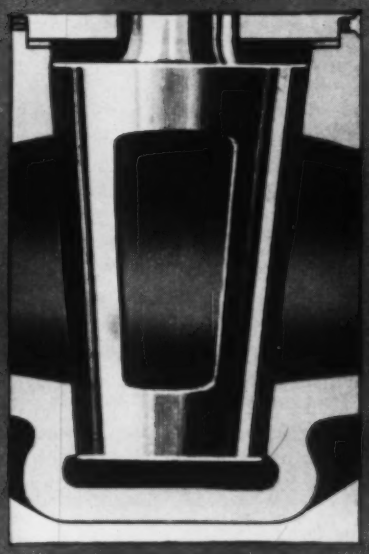
In the spots that count... Homestead® Valves are

STICK-PROOF





Built-in lever and screw affords instant operation



Seating pressure is mechanically relieved for easy turning

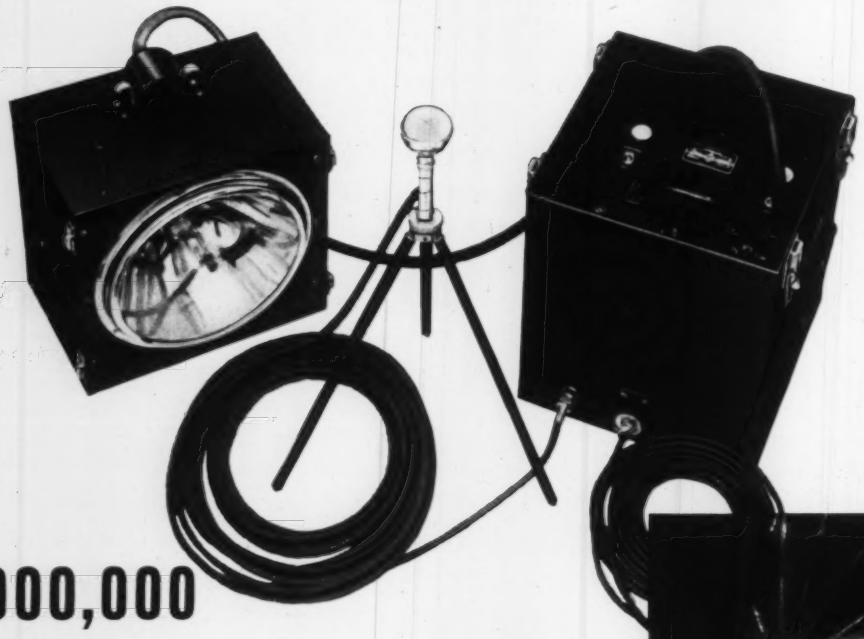
TROUBLE-FREE SERVICE is assured under all fluid, temperature and pressure conditions by the exclusive design of Homestead Lever-Seald Valves.

Instant stick-proof operation is guaranteed by a built-in lever and screw which mechanically relieves seating pressure. This controlled relief of pressure is only sufficient to overcome friction and to permit the plug to turn freely. What's more, all operating parts are protected from the damaging effects of corrosive or erosive service conditions and are completely weatherproof.

Write today for fully detailed Reference Book 39—Section 3. See for yourself how Homestead Lever-Seald Valves can solve your problems on high temperature, pressure or corrosive services.

h
v

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. Box A-38 • Coraopolis, Pa.



50,000,000 Candle Power In One Flash

The GR® Type 1530-A Microflash provides a "blinding" white light of short duration for single-flash photography of very rapidly moving objects. Flash intensity is *50 million* candle power — duration is only *2 millionths* of a second. During this short flash duration, an object moving at 1000 feet per second is displaced only two hundredths of an inch. Consequently, sharp photographs are readily obtained without blurring.

This instrument has been successfully applied to the study of many phenomena in pure and applied science, including investigations of the effects of abrasion, turbulence in liquids, and mechanical distortion at high rotational speeds. Other applications have included study of the disintegration of high-speed rotors, investigation of projectile flight and impact, and experimentation dealing with the propagation of fractures in various materials. In mechanical design, the Microflash has proved an indispensable tool for studying the action of springs, valves, cams, cranks, bearings and other parts moving at high speeds.

- ✔Power supply and trigger circuits are assembled in one metal case, lamp is in another. Two sections lock together for complete protection of all controls and ease in transportation.
- ✔Panel pushbutton initiates flash. Flash can also be tripped by noise or pressure wave associated with the action to be photographed; microphone and built-in amplifier are provided for such use.
- ✔Additional jack is available for flashing from any simple external contactor . . . from photoelectric cell, wire breaking under tension or impact, and other easily-built devices to suit the application.
- ✔Conventional camera equipment is used.
- ✔Accessories supplied include microphone with cable, tripod, spare pilot lamps and fuses, 2 spare flash lamps, and plug for connection to external-contactor trip jack.
- ✔Dimensions are 24⅛ x 13¼ x 11¼ inches, overall.
- ✔Net Weight is 72 pounds.
- ✔Price — $695.

Above: First photograph shows 20mm bullet just reaching scatter-proof glass. Focal point of concussion is readily seen along with maximum radius of fracture.

ULTRA-HIGH-SPEED PHOTOGRAPHY with G-R TYPE 1530-A MICROFLASH

Below: As bullet passes through, second photo indicates progressive shattering which is fairly well confined to point of contact.

GENERAL RADIO Company

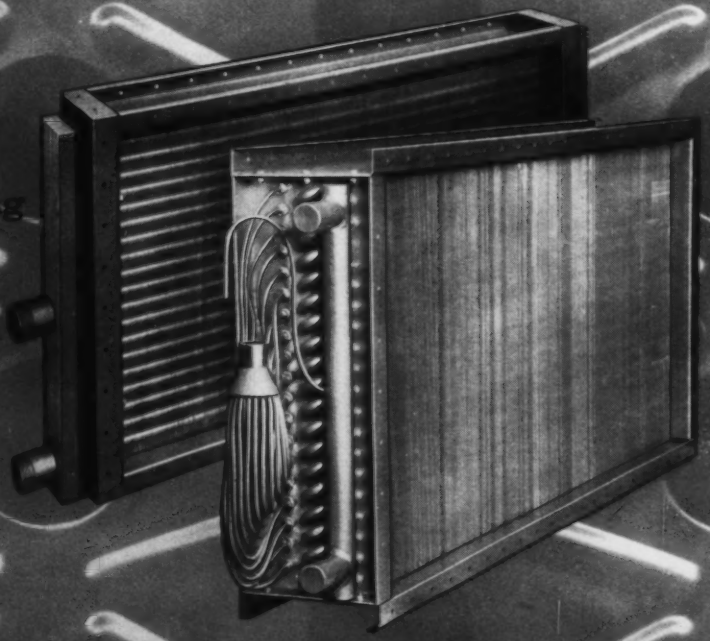
275 Massachusetts Avenue, Cambridge 39, Mass., U. S. A.

NEW YORK AREA: Tel. N. Y. WOrth 4-2722, N. J. WHitney 3-3140 **CHICAGO:** Tel. Village 8-9400
PHILADELPHIA: Tel. HAncock 4-7419 **WASHINGTON, D. C.:** Tel. JUniper 5-1088
SAN FRANCISCO: Tel. WHitecliff 8-8233 **LOS ANGELES 38:** Tel. HOllywood 9-6201
In CANADA, TORONTO: Tel. CHerry 6-2171

WE SELL DIRECT. Our District Sales Offices are staffed by engineers especially trained to help you in the selection of instruments and measuring systems best suited to your needs. We welcome your inquiries — will help solve your problems.

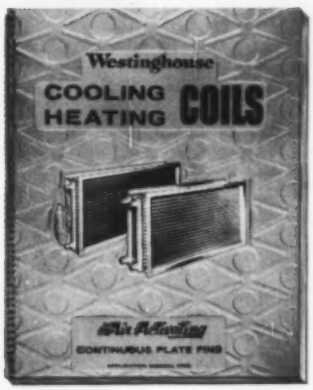
When you need heating and cooling coils...

these are better



because of this!

Air Activating Guides



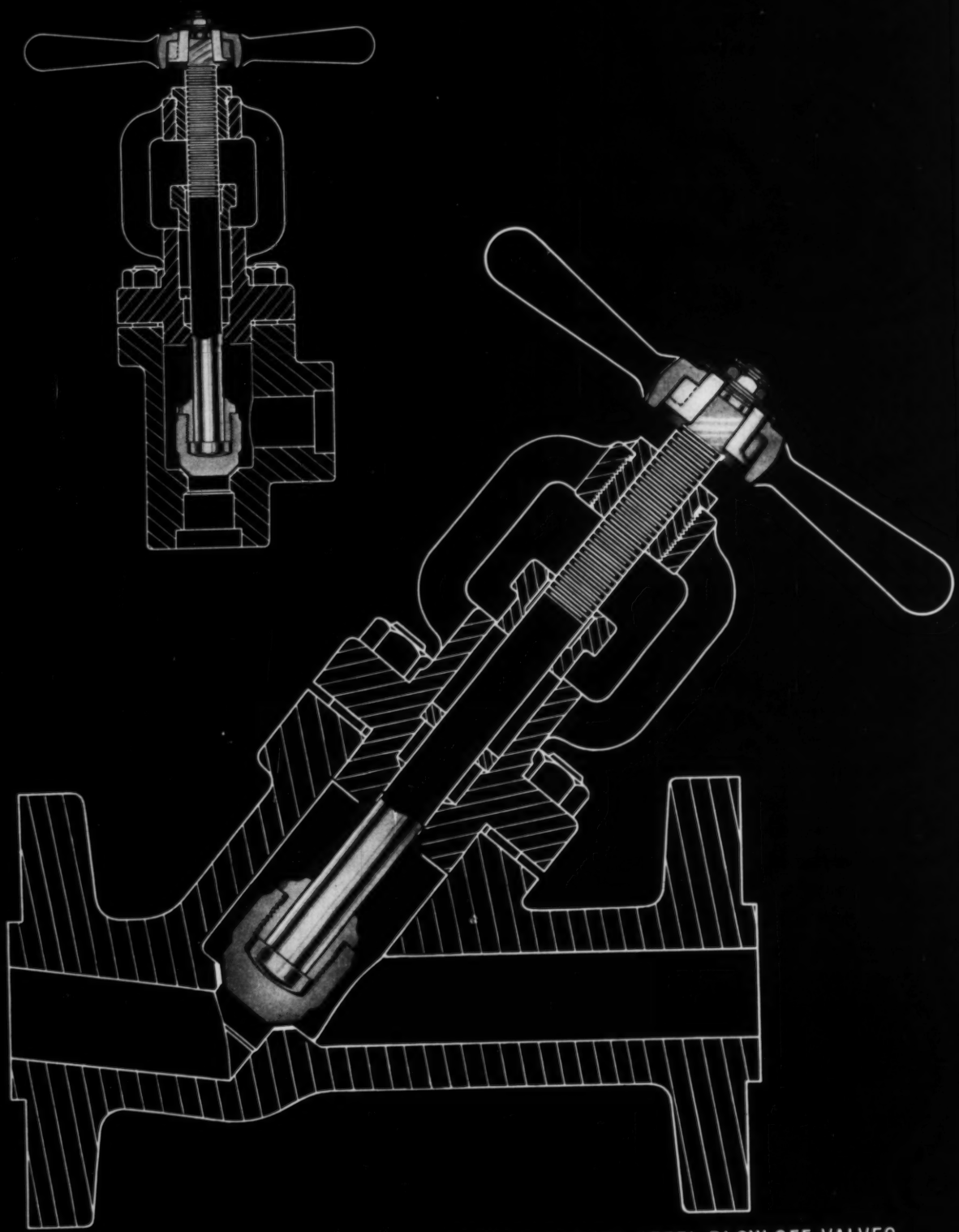
And more prime surface than any other coil!

Now! New Application Manual with complete data for consulting and designing engineers prepared in the format recommended by the Committee of 100 Prominent Consulting Engineers.

J-80674

Your Sturtevant Division Sales Engineer has your copy. Call him today, or write: Westinghouse Electric Corporation, Department F-3, Hyde Park, Boston 36, Massachusetts.

YOU CAN BE SURE...IF IT'S Westinghouse



EDWARD FORGED STEEL BLOW-OFF VALVES

What's New from Edward Valves

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Edward Drop Forged Blow-off Valves

. . . the first—and still the newest!

Fifty years ago, when boilers operated at 250 lb sp the first really efficient means of blowing-down was with "new" Edward blow-off valves. Today, with pressure in the 1800-2600 lb range and with water temperatures sometimes exceeding 600 F, corresponding improvements in Edward blow-off valves have been effected. For example, today all Edward blow-off valves have integral Stellite seats and Impactor* easy closing handles.

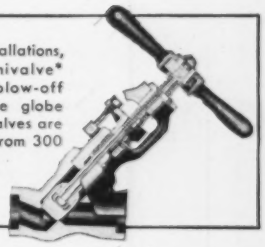
All over the world, high temperature-pressure steam power stations rely on these Rockwell-built Edward blow-off valves. The reasons are basic. Edward valves are simple and rugged in design, with no "trick construction." They operate easily, stay tight, need very little maintenance. If parts replacement is ever necessary, repairs are easier and less expensive than with any comparable valve.

The ASME Power Boiler Code requires steel valves wherever boiler drum pressure is above 200 psi . . . but, because blow-off service is severe at any pressure, operators of lower-pressure plants also have found it most economical to standardize on Edward valves.

Catalog 12-D2 tells the full story.

Recommended practice: Open valve *nearer* boiler first. Then slowly open other valve. After blow-off, close second valve first; then valve nearer boiler. This places greatest wear on blowing valve, assures a tight valve next to boiler, facilitates repair without a boiler shut-down.

Popular for high pressure installations, the Edward welded-bonnet Univalve* meets Code requirements for blow-off service and is ideal all-purpose globe valve as well. Edward blow-off valves are available in all pressure classes from 300 lb to 2500 lb in angle or straight-way styles, with flanged or welding ends.



Premium Features of Edward Blow-off Valves

- INTEGRAL SEAT of chromium-cobalt-tungsten alloy. Applied directly to body in a continuous ring, then machined in same set-up with bonnet guide bore for perfect alignment. Highly resistant to abrasion and corrosion.
- HARD-FACED DISK—Stellited for maximum resistance to abrasion and corrosion. Edward swivel-disk construction allows stem to lift vertically away from seat. No grinding or galling.
- POSITIVE BACKSEAT isolates packing from the high temperature zone. Line-contact backseat seals EValpak* valve packing from line pressure, permits repacking under pressure.
- IMPACTOR HANDLE, an Edward exclusive, is standard equipment. Several times more effective than ordinary handles or handwheels in opening or closing valves.

EDWARD VALVES, INC.

1228 West 145th Street, East Chicago, Indiana

Subsidiary of

ROCKWELL MANUFACTURING COMPANY

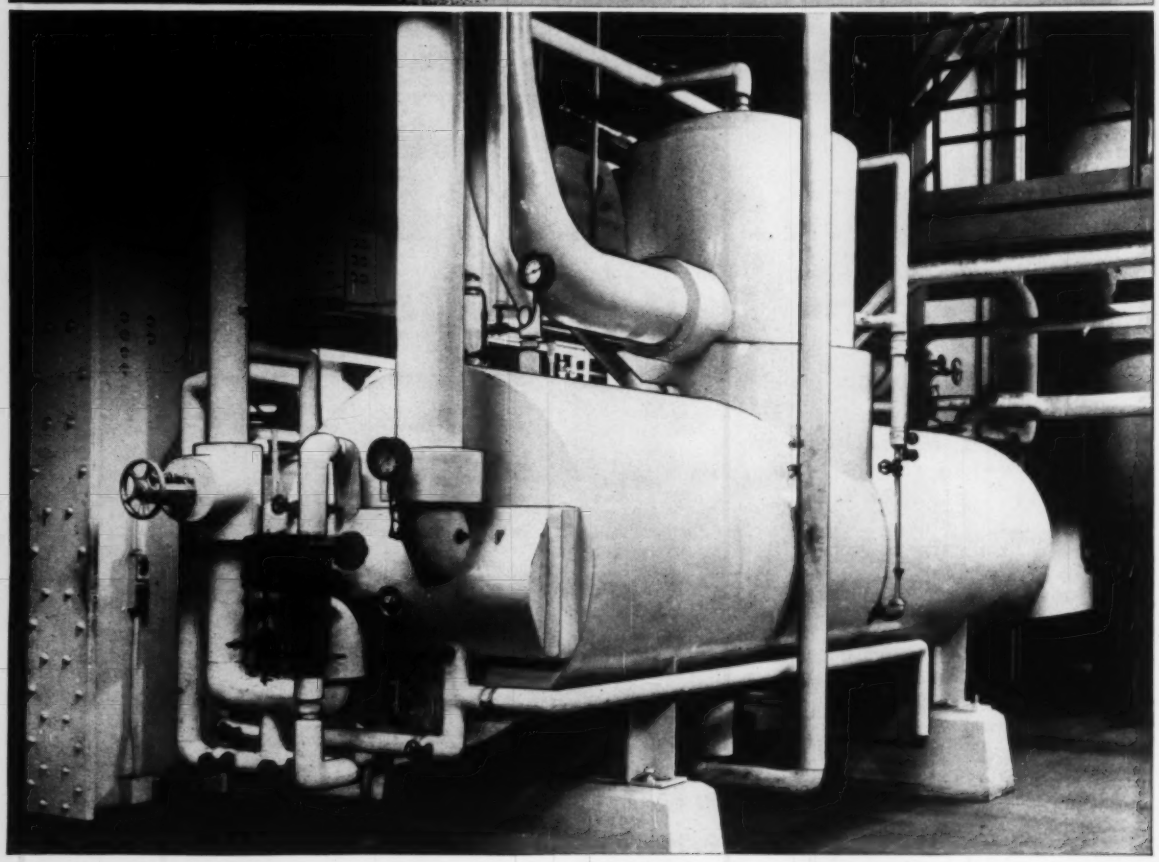
Represented in Canada by

LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St. W., Montreal 1, Que.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

*T. M. Reg. U. S. Pat Off.

PROGRESS IN POWER through PROGRESS IN HEAT TRANSFER EQUIPMENT



.2 ppm NOW; .1 ppm COMING SOON

Modern steam and nuclear power plants require boiler water so pure that even the finest drinking water would contaminate it.

Requirements for boiler water make-up of the highest purity can be met readily by Yuba's modern bubble tray evaporators.

Present installations are producing vapor having less than .2 ppm total solids. Shown above is a bubble tray evaporator at the Russell Station of the Rochester Gas & Electric Corp. whose vapor tested at .2 ppm with a shell concentration of 2800 ppm.

With slight changes, on which Yuba is now working, the purity will be .1 ppm or better. No wonder Yuba can *guarantee* evaporator performance of not more than .5 ppm at 3000 ppm shell concentration!

For *plus* performance, specify equipment manufactured by the Yuba Heat Transfer Division, formerly the Heat Exchanger Division of The Lummus Co. And for solutions to difficult engineering problems, consult Yuba engineers.

YUBA HEAT TRANSFER DIVISION

HONESDALE, PENNSYLVANIA
NEW YORK SALES OFFICE: 530 FIFTH AVENUE
REPRESENTATIVES IN PRINCIPAL CITIES

Other Yuba Divisions
Adsco Division, Buffalo, N. Y.
California Steel Products Division, Richmond, Calif.
Yuba Manufacturing Division, Benicia, Calif.

YUBA

STEAM SURFACE CONDENSERS
EVAPORATORS
STEAM JET REFRIGERATION
STEAM JET AIR EJECTORS
FEEDWATER HEATERS
BAROMETRIC CONDENSERS

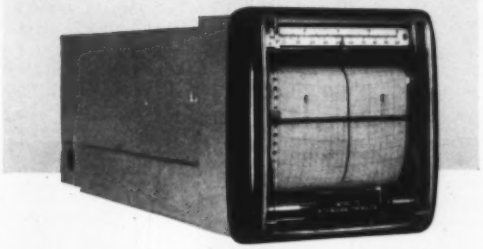
YUBA CONSOLIDATED INDUSTRIES, INC.

NEW! pneumatic transmitting tachometer with DIRECT LINEAR SIGNAL

the Foxboro Type 16A Pneumatic Speed Transmitter

- **mounts in any position**
- **accurate to ±½% across entire range**
- **adjustable span and zero**
- **Dust-tight gasketed case continuously purged**
- **Low cost compared with other recording tachometers**
- **Operates on simple force-balance mechanical principle.**

Direct-connects to remote pneumatic recorder or controller, such as Consotrol panel recorder shown below.



At last — a tachometer with 3-15 psi air signal *directly proportional* to rpm! Speed changes are recorded on a uniform-scale chart. Accurate measurements of rpm are easy to read throughout the entire range. No crowded bottom scale!

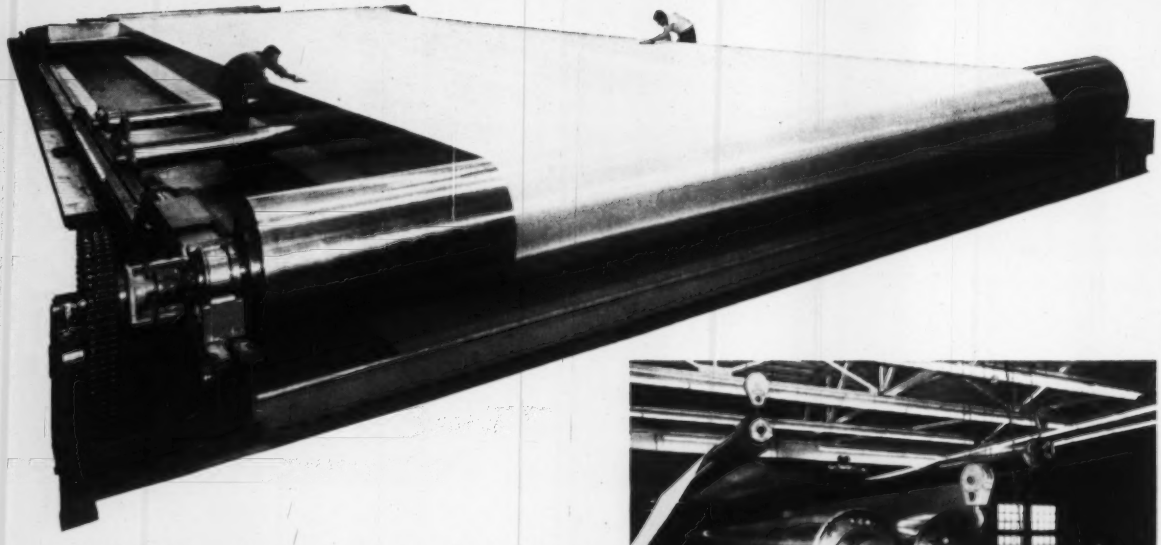
The Type 16A Speed Transmitter is available for ranges from 0-320 rpm to 0-5300 rpm. Full-scale accuracy of ±½% is consistently maintained. Small and light weight, it can be mounted *in any position* — never needs lubrication.

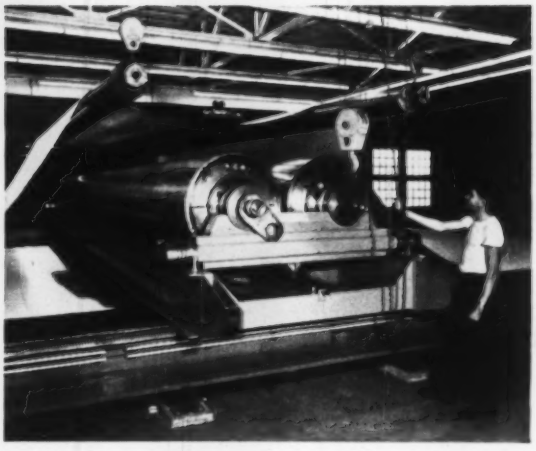
For rotating equipment having wide speed variations, the Type 16A is ideal. It's available for either clockwise or counter-clockwise rotation, and can easily be incorporated into any present pneumatic control system. Write for full details. **The Foxboro Company, 966 Neponset Ave., Foxboro, Massachusetts, U.S.A.**

FOXBORO
REG. U. S. PAT. OFF.

PNEUMATIC SPEED TRANSMITTERS

In specialized applications...
ACIPCO *CENTRIFUGALLY SPUN* STEEL TUBES





Appleton Wire Works, Inc., manufactures high quality fourdrinier wires for paper making machines. These fine-mesh wires are woven in widths up to 340 inches and lengths over 180 feet.

At its Montgomery, Alabama, plant, Appleton Wire Works, Inc. uses ACIPCO steel tubes— centrifugally spun and polished at Acipco—as stretch rolls on the huge finishing table. These 35.625″ OD, 410″ long rolls must be both dimensionally stable and balanced and must have a polished surface which will not affect the delicate woven wire surface mechanically or chemically.

Here is another example of Acipco versatility. If your application requires heavy wall steel or alloy iron tubes with special physical, chemical or metallurgical properties "built-in," Acipco can serve you. Investigate Acipco's complete "one source—from start to finish" facilities. A call or letter will bring full information on Acipco centrifugally spun tube applications in your field.

VERSATILE ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

Size Range: Lengths up to 410″ to meet modern machinery requirements have been produced. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

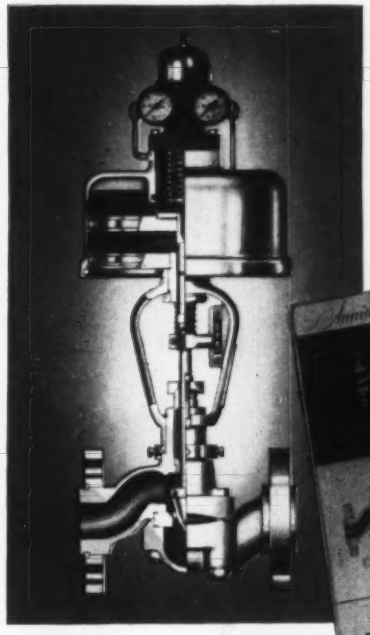
Analyses: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special non-standard analyses.

Furnished: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

SPECIAL PRODUCTS DIVISION

AMERICAN CAST IRON PIPE CO.

BIRMINGHAM 2, ALABAMA



HOW *ANNIN* DOES IT.

The Best Way Yet in Process Control

SPLIT BODY CONSTRUCTION . . . SINGLE SEAT DESIGN

No other process control valve offers the advantages in economy and adaptability as that provided by the Annin valve. The split body eliminates pockets and shoulders that create undesirable turbulence and accumulated solids, reduces erosion and allows consistent flow behavior with a wide range of fluids under all conditions.

Superior body design permits conversion in any alloy from the basic Globe Body to Corner, Angle or 3-way construction.

OPERATORS

Three basic Annin operators bring new and improved performance. The DOMOTOR operator is the most responsive, precise positioning and fastest pneumatic operator available... Electro-pneumatic or pneumatic CYLINDER operators, for remote shut-off applications, are designed to withstand continuous "on-off" operations... MANUAL operators, for precise throttling of flow rate and tight closure.

INTERCHANGEABILITY OF COMPONENTS

Applications unlimited are provided by interchangeability of Annin component features. Three types of operators, and five types of packing assemblies (plain extension, bellows seal, doolseal, cooling fin and standard) are interchangeable on one yoke and one body.

SEND FOR THE ANNIN CATALOG—
AN ENCYCLOPEDIA OF VALVE EXPERIENCE AND LEADERSHIP

SIMPLICITY IN DESIGN AND MAINTENANCE

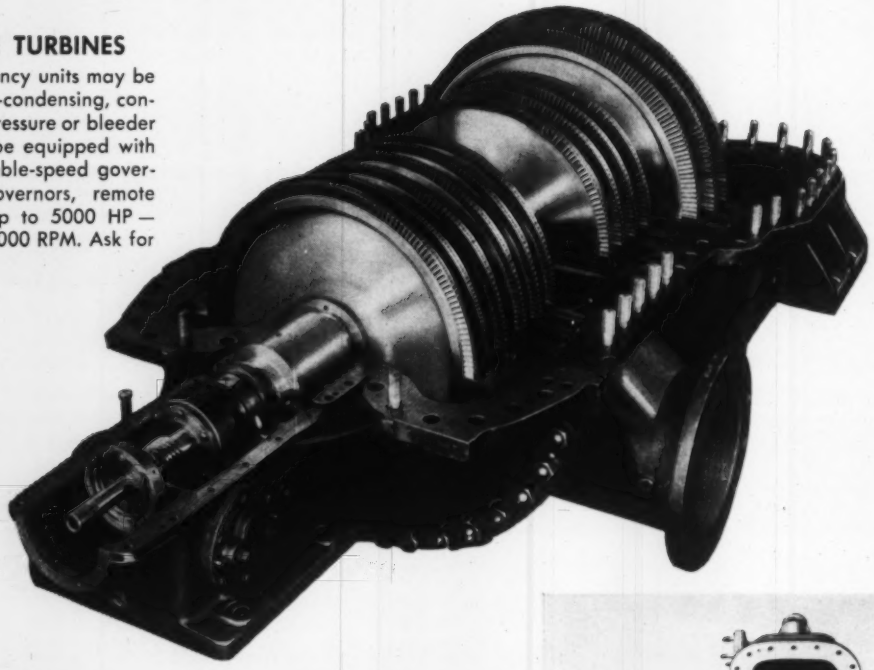
The advantages of Annin single seat, split valve bodies, coupled with the design characteristics of Annin Domotor and other operators, provide control engineers with valves that can be installed without compromise in materials, response, tight closure, piping flexibility and dependability... making possible a reduction of parts from 50% to 75%, lower initial cost, lower spare parts inventory, lower maintenance.

THE ANNIN COMPANY
Division of The Annin Corporation
1040 S. Vail Ave., Montebello, California

ANNIN VALVES

MULTI-STAGE TURBINES

These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



There's a **Terry turbine** for every mechanical-drive requirement

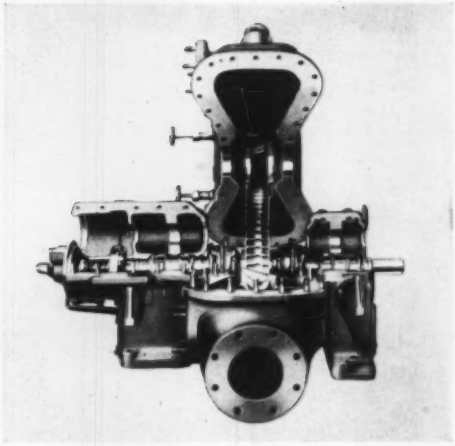
The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of *the leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

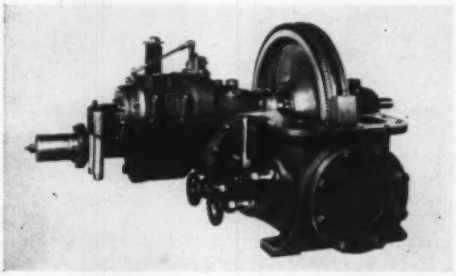
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



SOLID-WHEEL TURBINES

Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



AXIAL-FLOW IMPULSE TURBINES

Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.

TT-1209

world's finest drawing pencil

A.W.FABER-CASTELL

Product of nearly 200 years of uninterrupted experience

The Masters of the drawing board on every continent say that CASTELL #9000 is the world's finest wood-encased pencil.

Why?

Because this green polished perfect drawing tool is saturated with **"Black Gold"** graphite, the purest black mineral known to man, that assays at more than 99% pure carbon.

Because its low index of friction makes each CASTELL stroke outstandingly smooth, a pleasure to work with.

Because our exclusive microlet-milling process reduces granules to optimum shape and size, producing an opaque adhesion that gives you cleaner, sharper blueprints.

We could talk about CASTELL's Color-Coding that makes for instant identification — its exceptional lead strength and durability, its fine-grained cedar wood impregnated with rare waxes, its perfectly-graded scale of 20 degrees, 8B to 10H.

But the really significant answer is — *almost 200 years of uninterrupted manufacturing experience–since 1761.* Perhaps the next 200 years will produce a markedly superior pencil, but if it does you can be sure it will continue to carry the A.W.FABER-CASTELL imprint.

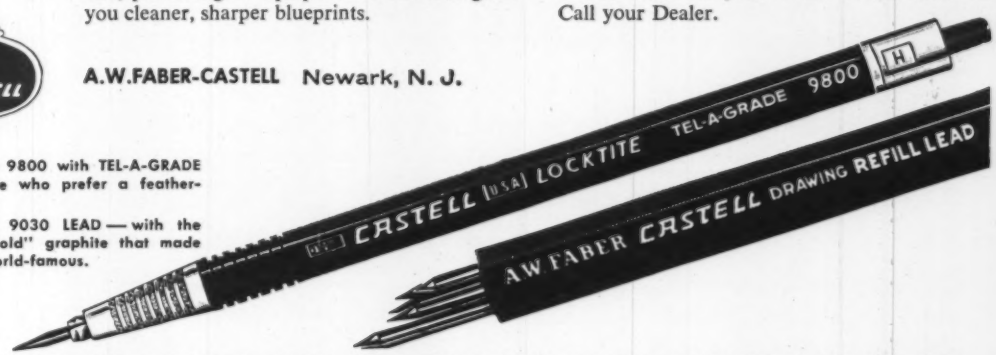
You owe it to your career to use CASTELL. Call your Dealer.

FABER-CASTELL

A.W.FABER-CASTELL Newark, N. J.

CASTELL LOCKTITE 9800 with TEL-A-GRADE indicator, for those who prefer a feather-weight holder.

Imported CASTELL 9030 LEAD — with the identical "Black Gold" graphite that made CASTELL #9000 world-famous.



PREFERRED BY PROFESSIONALS IN EVERY CIVILIZED COUNTRY ON EARTH.

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.
2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.
3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.
4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.
5. Sleeves carried on bearing rings located on transverse center line of hub spline faces (the load-carrying surfaces) — no crank action, no vibration.
6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3406 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD.
This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
Engineered Products Sold with *Service*.

Pacific Process Pump **EXTRAS** bring **EXTRA PROFITS** to you!

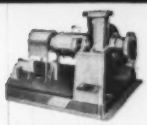
EXTRA CORROSION ALLOWANCE—All Pacific Process pumps are custom-built with case casting thickness in excess of actual pressure-temperature requirements. This provides a liberal allowance for corrosion-erosion and a high safety factor.

EXTRA HEAVY CONSTRUCTION—Pacific process pumps are engineered to combine the strength necessary for continuous heavy duty service with design simplicity and accessibility for low maintenance cost. All parts in contact with pumped liquid may be fabricated from any commercially available ferrous or non-ferrous metal.

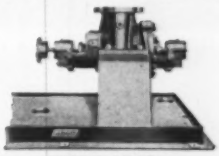
EXTRA LONG LIFE—Guided inlet flow reduces friction losses—insures minimum required NPSH. Dynamically, radially, and axially balanced moving parts eliminate vibration that would cause damage to rings, bushings, bearings, packing or mechanical shaft seals and excessive radial and thrust loads on bearings. Result—greatly increased availability for profitable operation.

Write for bulletins—please specify pump type.

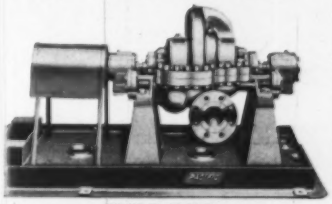
MAXIMUM PARTS INTERCHANGEABILITY is an extra feature in PACIFIC PROCESS PUMPS



TYPE SVC
To 850°F.—25 to 3200 GPM
To 600 PSIG—To 650 DIFF. HD. FT.



TYPE HVC
To 850°F.—600 to 4500 GPM
To 600 PSIG—To 1000 DIFF. HD. FT.



TYPE RHC
To 500°F.—50 to 3000 GPM
To 700 PSIG—To 1300 DIFF. HD. FT.

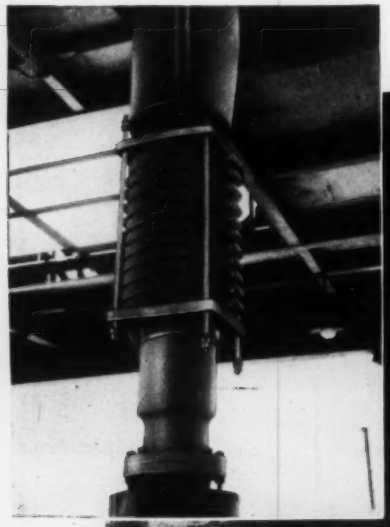
TYPE AC
To 850°F.—100 to 2500 GPM
To 1000 PSIG—To 2600 DIFF. HD. FT.

PACIFIC PUMPS INC
A Division of Dresser Industries, Inc.
HUNTINGTON PARK, CALIFORNIA

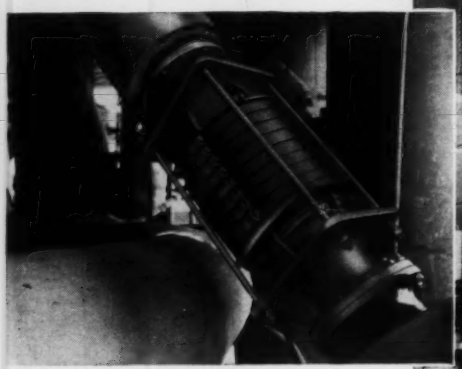
PACIFIC®

Offices in All Principal Cities

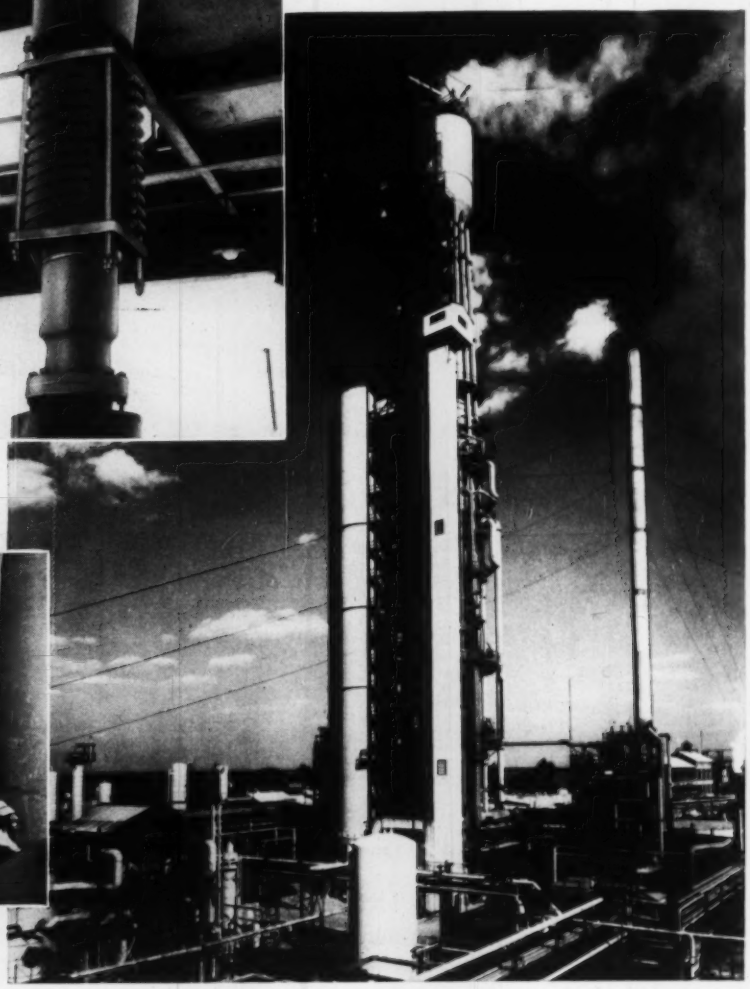
CP-19



ADSCO Corruflex Expansion Joint with #316 stainless steel element. From the position of the tie-rods, note the pipe movement the joint is absorbing.



In this section of the Houdriflow unit, there are 12 ADSCO Corruflex Expansion Joints with #316 stainless steel elements. Temperature here is 1100°F.



Houdriflow Catalytic Cracking Unit, Marcus Hook Refinery, Sun Oil Co.

LET THE PIPES SQUIRM . . .

ADSCO EXPANSION JOINTS *are on the job*

Here, at the Marcus Hook Refinery of Sun Oil Co., temperatures run high. The piping naturally moves around a bit. But Sun engineers don't worry because they installed 62 ADSCO Corruflex Expansion Joints to take the movement. Lateral offset, angular rotation, off-tackle slants . . . name it and ADSCO Expansion Joints can absorb it. If you expect your pipes will get frisky, call the nearest ADSCO sales-engineer. He'll know what to do.

ADSCO DIVISION

20 MILBURN STREET

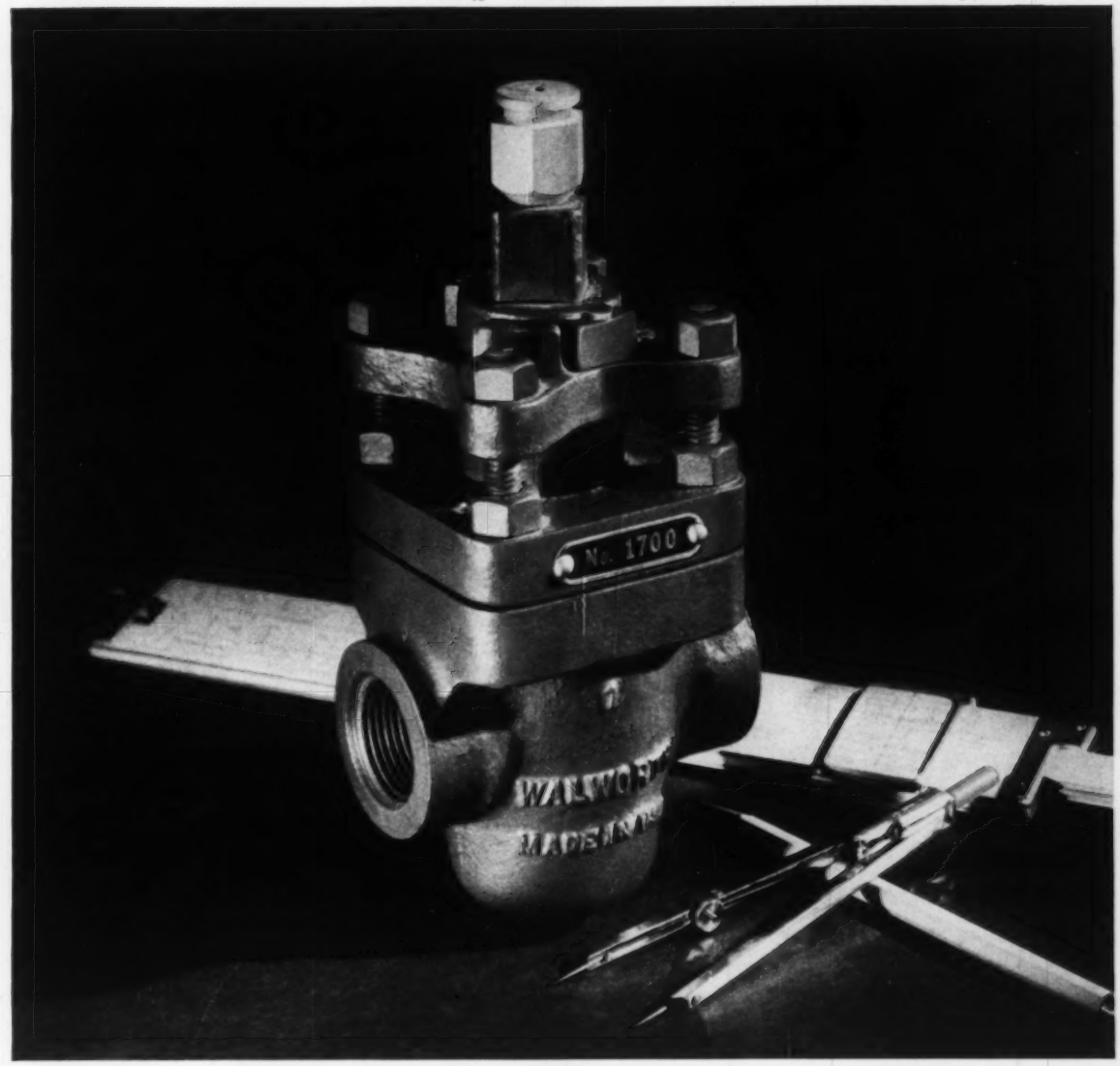
BUFFALO 12, NEW YORK

Member, Expansion Joint Manufacturers Association

YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

Illustrated here is the Walworth Lubricated Plug Valve No. 1700, available in sizes from ½" to 5" inclusive, suitable for 200 pounds water, oil, or gas working pressure.



problem-solvers for tough jobs

*LPV's by WALWORTH

If you're familiar with the basic advantages of Plug Valves, you know why Walworth Lubricated Plug Valves work so well in really tough spots. You know about their direct port opening . . . their dead tight shut off. Seating and sealing surfaces are fully protected from attack by fluids being handled by insoluble lubricants.

*Lubricated Plug Valves

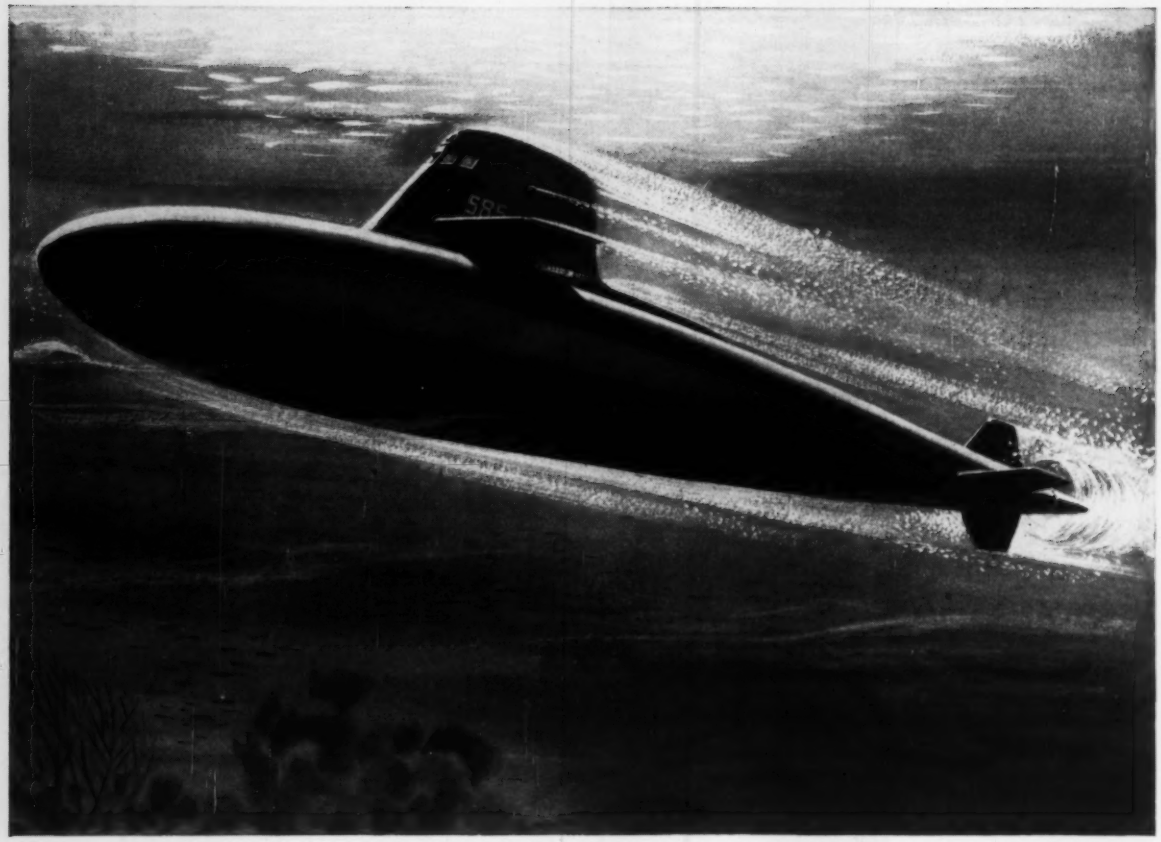
Remember, you can get Walworth LPV's in all sizes . . . from ½ to 30 inches . . . for pressures up to 5000 psi and for vacuum service . . . in a number of different styles and patterns. For more information about LPV's and for your copy of the new Walworth LPV Circular, see your local Walworth Distributor.

WALWORTH

750 THIRD AVENUE, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. SOUTHWEST FABRICATING & WELDING CO., INC. • M&H VALVE & FITTINGS CO. • WALWORTH COMPANY OF CANADA, LTD.



Sandusky cylinders help the Skipjack
CRUISE, DIVE, STEER, BREATHE and FIGHT!

Centrifugally cast cylinders by Sandusky play vital roles in the U. S. Navy's newest atomic-powered submarine, No. 585 *Skipjack*, as components of the nuclear propulsion system, the steering and diving systems, the torpedo firing mechanism, and radar and induction mast assemblies.

The *Skipjack* is the prototype of a new series of seven submarines all with blimp-shaped hulls for greater underwater speed. Her design and materials specifications were laid down by the U. S. Navy and her builder, The Electric Boat Division of General Dynamics Corporation, who chose Sandusky Centrifugal Castings to do more than ten jobs in structural, mechanical, pneumatic, and hydraulic applications.

All of these components – centrifugally cast of heat and corrosion-resistant stainless steels, high-strength carbon steels, Monels, and bronzes–provided the *Skipjack's* designers with the required mechanical and physical properties at the lowest cost.

You, too, may find a ready solution to your cylindrical problems in Sandusky Centrifugal Castings. We invite your inquiries.

Sandusky cylinders are cast and machined in this range:

From 7" to 54" O.D.

Up to 33 ft. in length (depending on diameter)

Light or heavy-walled

In a variety of alloys including Stainless, Carbon, Low Alloy Steels. A full range of Copper-Base, Nickel-Base Alloys.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.
SANDUSKY, OHIO

compressor-user survey shows

FEATHER VALVE PREFERRED 2 TO 1!

FEATHER VALVE

VALVE A

VALVE B

A recent survey of compressor users put the amazing Feather* Valve first by far in all four operating categories —simplicity of construction, efficiency, low maintenance cost and quiet operation. In addition, the Feather Valve was picked as the preferred compressor valve 2 to 1 over the nearest competing type of valve!

The lightest, fastest-acting valve available, the amazing Feather Valve provides very sharp action with virtually no slip or back-flow. It works with no impact . . . has no buffer plates or cushioning devices. Practically indestructible it assures long life with negligible maintenance costs. When buying your next compressor, look into Worthington's complete line of Feather Valve units. Worthington Corporation, Harrison, N. J.

*REG. U. S. PAT. OFF.

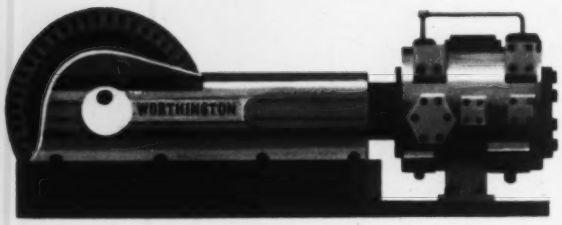
WORTHINGTON

NO COMPROMISES

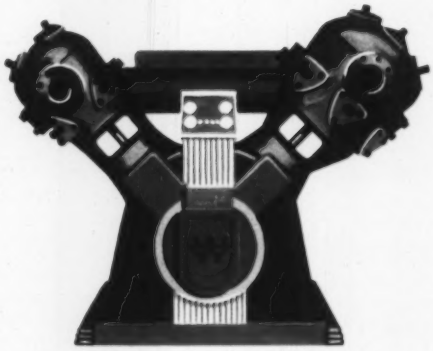
when you select from Worthington's complete compressor line

The Worthington line includes a compressor and drive for *every* compression job. Sizes range up to 10,000 hp and gas pressures to 35,000 psi. In addition to the types shown below, Worthington builds many others including steam engine, steam turbine, and engine driven machines in many types and sizes. For more information write specifying the bulletin noted below to Worthington Corporation, Section 36.1, Harrison, N. J. In Canada: Worthington Canada Ltd., Brantford, Ont.

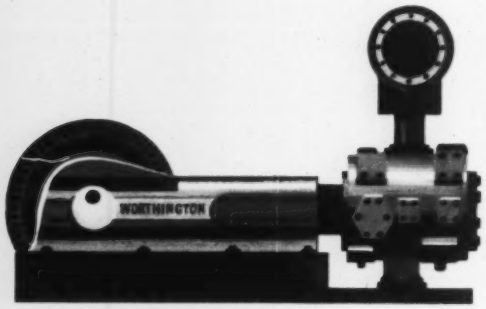
WORTHINGTON



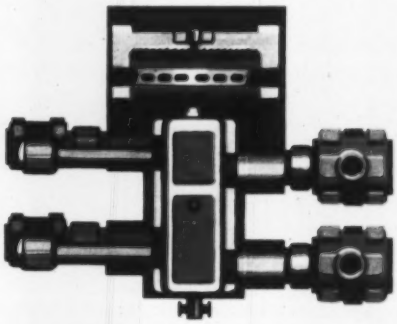
Single horizontal compressor, type HB
5 to 150 hp—Bulletin L-640-B1E



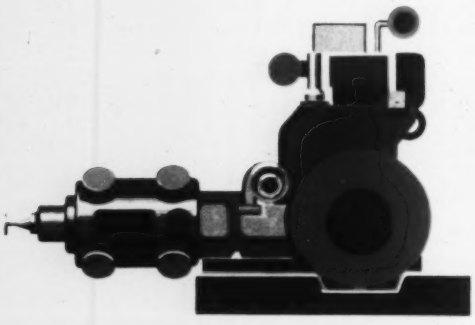
Vertical angle compressor, type YC & DYC
75 to 500 hp—Bulletin L-676-B1A



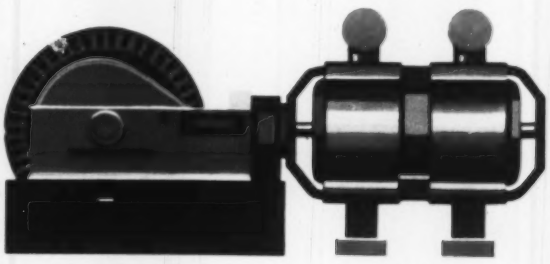
Horizontal duplex compressor, type DC
250 to 3,000 hp—Bulletin L-675-B1C



Balanced opposed compressor, type BDC
400 to 10,000 hp—Bulletin L-679-B1A



Angle gas-engine compressors, types SLHC and SUTC
375 to 2,500 hp—Bulletin S-550-B27; S-550-B23D

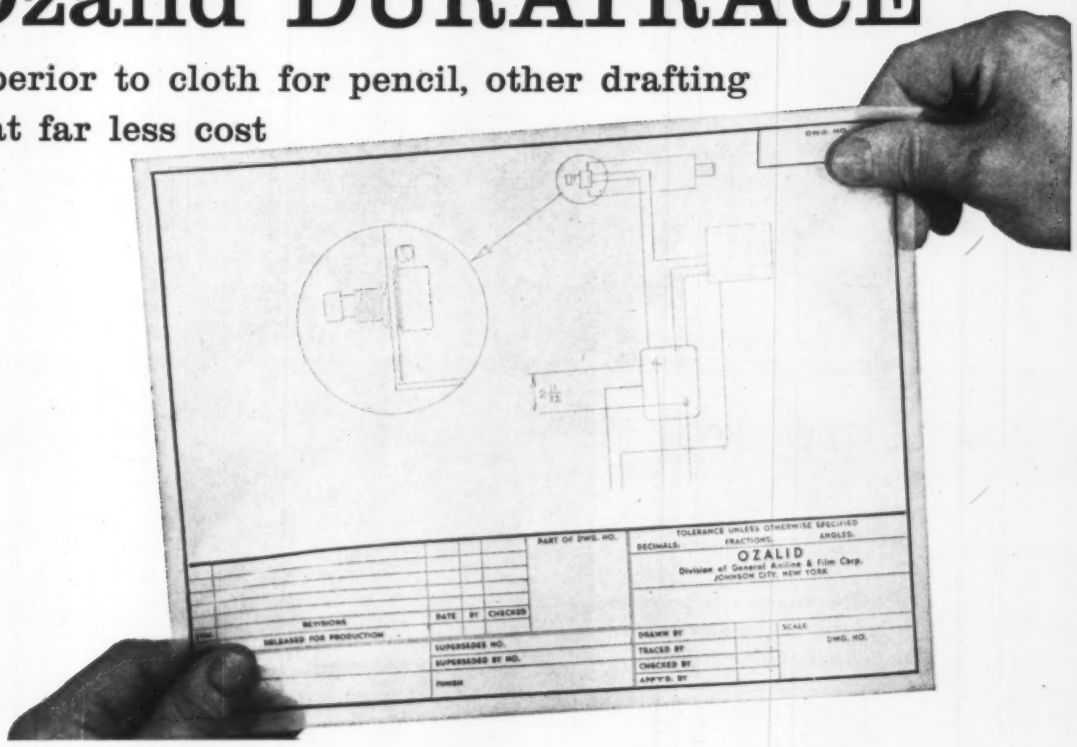


Vacuum pump, 200 to 150,000 CFM—Bulletin L-600-B9-4

A really NEW drawing material...

Ozalid DURATRACE®

superior to cloth for pencil, other drafting —at far less cost



Extremely durable, practically ageless—that's new Ozalid Duratrace drawing film. Duratrace can speed your drafting operations, insure greater accuracy and finer prints. It can be used under all climatic conditions and it will still maintain its exceptionally high-dimensional stability.

And Duratrace saves you money! Not only will it outperform the highest quality, moistureproof pencil tracing cloths in every respect—it actually costs 15% to 20% *less!*

HERE ARE A FEW OF ITS OUTSTANDING ADVANTAGES:

- **Makes drafting easier, improves accuracy**
  Duratrace has an exclusive new fiber-free matte surface that takes pencil better than any cloth available. It lets you use *hard* pencils for greater accuracy, cleaner drawings. It erases easily and quickly without smudging. And Duratrace lies *flat*, won't curl—even after being rolled for long periods.
- **Gives you better prints, faster**
  The very high translucency of Duratrace means faster copying in your whiteprint or blueprint machine—copies with maximum contrast. Duratrace won't stretch, melt or peel in your copying machine. Distortion of drawings is ended.
- **Stands up to roughest usage—indefinitely**
  Easy to handle and file, Duratrace resists wear and tear—is almost ageless! Its fold and tear strengths far exceed those of cloth, most other films. Duratrace can't fray, become "dog-eared," crack, chip, or turn brittle. It's nonyellowing . . . *really* waterproof; can be filed indefinitely, without deterioration!

Why not test this advanced new drawing material and discover for yourself its many advantages and applications? Just mail the coupon and you will receive free sample and price information.

OZALID®
Products for Design

A Division of General Aniline & Film Corporation
In Canada: Hughes Owens Company, Ltd., Montreal

DURATRACE, Division of Ozalid
Dept. U-6
Johnson City, New York

Please send me a free test sample of Ozalid DURATRACE. I understand there is no obligation.

Name_____ (PLEASE PRINT)

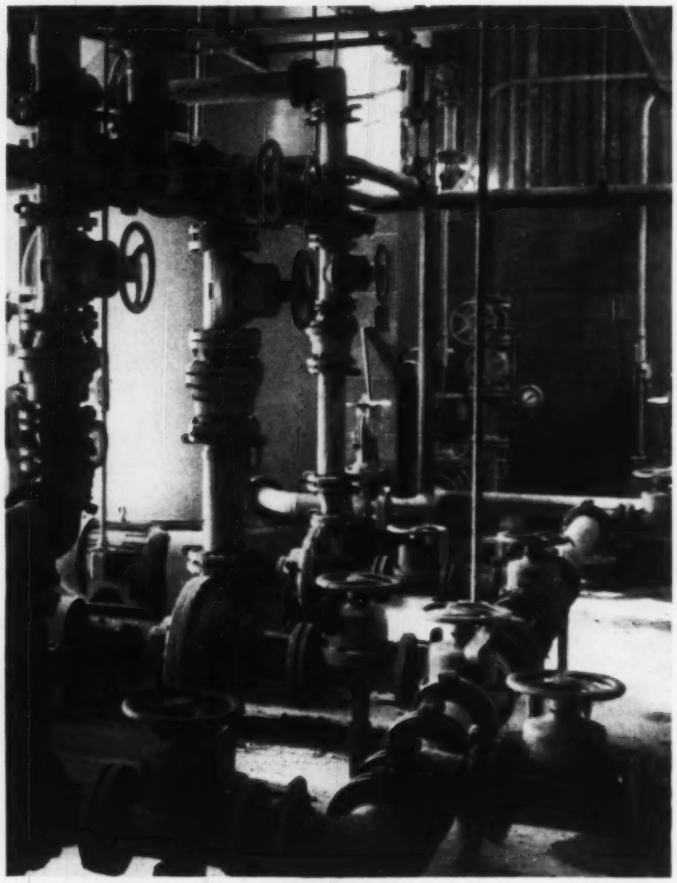
Company_____

Position_____

Address_____

City_____ State_____

Maintaining maximum flow in serum lines with minimum pressure drop



Goodyear Tire & Rubber Company reports no valve clogging or interruption to flow in handling viscous fluids — with Grinnell-Saunders Straightway Diaphragm Valves.

Grinnell-Saunders Straightway Valves are now in use on serum lines of the Goodyear Tire & Rubber Company. Serum is a suspension of rubber particles in an acid brine solution. The installation pictured above is in Goodyear's Synthetic Rubber plant at Houston, Texas.

Grinnell-Saunders Straightway Valves were selected for this service because of their straight-through design. Material in process cannot build up and choke off flow because there are no pockets or gate trenches to trap solids. The straight-through feature also assures speed, ease and economy of rodding out, when necessary. When a diaphragm must be replaced — that job, too, can be done quickly, without removing the valve body from the line.

Isolation of operating parts from the fluid stream is still another important advantage of the Grinnell valve . . . eliminating corrosion and clogging of the valve mechanism while, at the same time, preventing contamination of product in the line.

Grinnell-Saunders Diaphragm Valves are available in a wide range of body, lining, and diaphragm materials to meet different service conditions. To secure further information, contact the Grinnell branch office nearest you — or write directly to Grinnell Company, Inc., 277 West Exchange Street, Providence, R. I.

Open

Diaphragm lifts high for streamlined flow in either direction. No irregular surface to trap deposits.

Closed

Diaphragm presses tight for positive closure, even when handling viscous or fibrous materials.

GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

BLUE-dyed Asbestos tells you that your Flexitallic Gasket is

RIGHT FOR A GIVEN SERVICE

Practices in design and construction make Flexitallic Gaskets different from others in the spiral-wound industry. In Flexitallic Gaskets, the compression characteristics for a given pressure series are *always* related to the bolting load for that series.

Once the design is right for a given service, Flexitallic Gaskets are made under exacting mechanical controls to assure that manufactured gaskets conform to specification.

The blue dye in the Canadian asbestos filler indentifies Flexitallic Gaskets for engineers who want the right gasket for each sealing requirement.

Whatever the service conditions may be—vibration, weaving, thermal and mechanical shock, and other joint stresses—the precision design and construction in Flexitallic Gaskets are your assurance of satisfactory service.

FLEXITALLIC GASKET CO.
8th & Bailey Sts. Camden 2, N.J.
Representatives in principal cities

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

Flexitallic is a registered tradename. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

WHY YOU SHOULD SPECIFY

Curtis

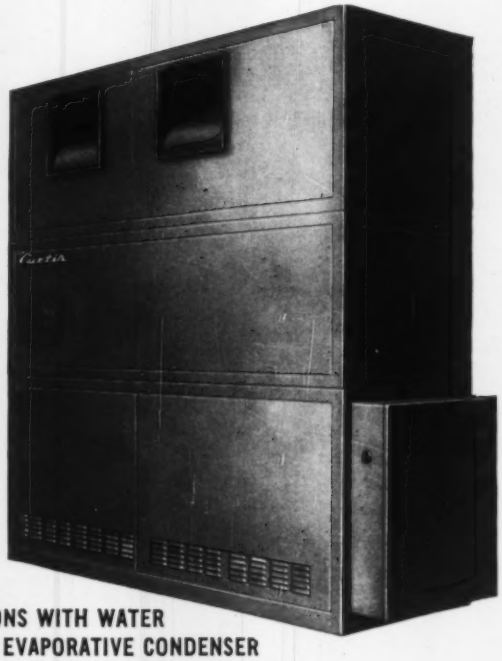
PACKAGED AIR CONDITIONING

INSTALLATION EASIER: Line assembled at the factory —eliminates expensive field labor.

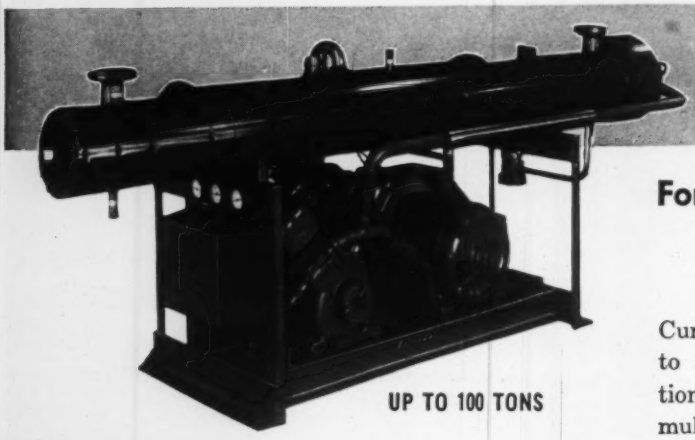
PERFORMANCE KNOWN: Curtis units are run-in at the factory and guaranteed to deliver their rated tonnage. Assures a BALANCED SYSTEM.

SUPERIOR EQUIPMENT: Long life, quiet, trouble free, economical operation.

DELIVERY ON TIME: Curtis can meet your delivery requirements, a decided advantage over multiple supplier delivery promises!



UP TO 50 TONS WITH WATER COOLED OR EVAPORATIVE CONDENSER



UP TO 100 TONS

PACKAGED LIQUID CHILLERS

For Air Conditioning Process Cooling Refrigeration

Curtis packaged liquid chiller lends itself to a widely diversified field of applications—air conditioning, refrigeration and a multitude of process cooling procedures. Available in capacities up to 100 tons.

REMEMBER, you can count on

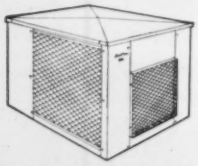
Curtis

OUR 104TH YEAR

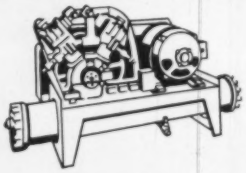
MANUFACTURING COMPANY • REFRIGERATION DIVISION

1940 Kienlen Ave., St. Louis 20, Mo.

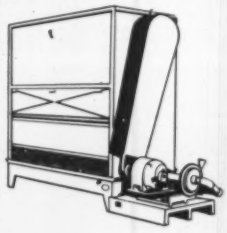
Represented in Canada by
T. M. Hall Ltd., 30 Milner St. Montreal West 28, P.Q., Canada



Air Cooled Air Conditioning Units, 3-5-7½ tons. Residential and commercial application.



Condensing Units up to 100 tons.



Cooling towers and evaporating condensers, air handling units to match.

C-33

New extreme-high-temperature lubricants for missiles and supersonic aircraft **SHELL ETR GREASES**

One of the serious lubricating problems faced by designers of missiles and supersonic aircraft has been solved by scientists at Shell Research Laboratories.

The problem: to find a grease which would permit components to operate with certainty under extreme high temperatures. Co-operation with representatives of bearing manufacturers and military personnel resulted in a completely new class of greases—SHELL ETR GREASES.

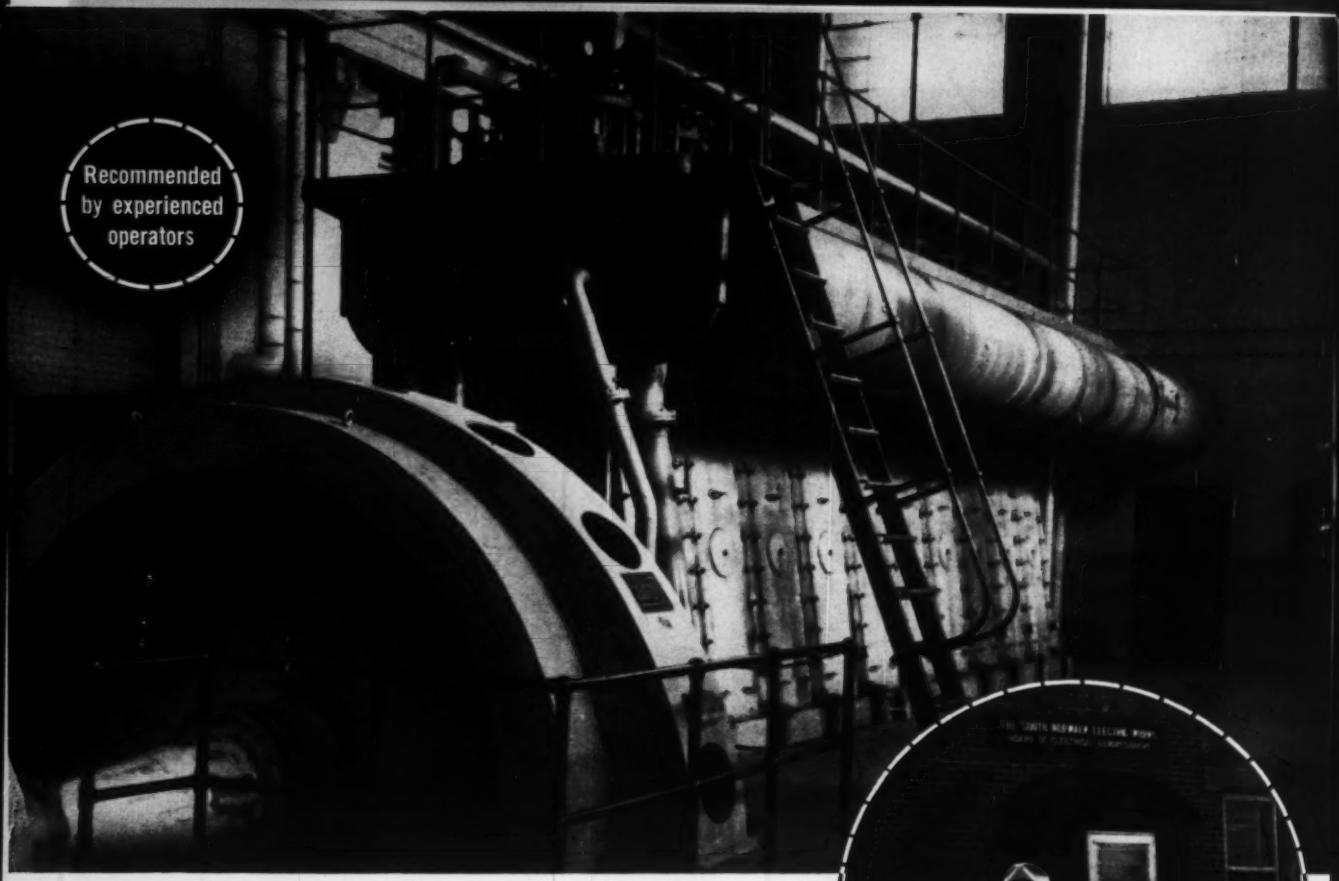
These greases can easily withstand temperatures up to 600°F. They give superior lubricating performance because of a special thickener—an organic vat dye—which has exceptional heat stability and jelling efficiency.

If you are presently in the market for an ultra-high-temperature-range grease, we will be glad to provide more information on Shell ETR Greases.

SHELL OIL COMPANY

50 West 50th Street, New York 20, N.Y.
100 Bush Street, San Francisco 6, Calif.

SHELL



Recommended by experienced operators

"confidence in Nordberg . . . we have purchased two additional engines since our first installation"

. . says *Mr. E. J. SPLAN, Gen'l. Supt., South Norwalk Electric Works*

The South Norwalk Electric Works, South Norwalk, Conn., has a long and successful record of supplying reliable electric lighting and power service to its customers. Playing a major role in providing this dependable power are three big Nordberg 2-cycle engines, totaling 10,250 hp.

Mr. E. J. Splan, Gen'l. Supt., speaking for the Board of Electrical Commissioners, has this to say about Nordberg engines *and* Nordberg *service:*

"*Our confidence in Nordberg engines is best expressed by the fact that we have purchased two additional engines since our first installation. We were pleased to find that Nordberg's interest in a customer did not cease with the sale of an engine, and after 17 years of business association that solicitude remains the same. We consider them a friend as well as a supplier of excellent Diesel engines.*"

These, then are additional reasons why experienced operators rely on *Nordberg* to provide the best answer to municipal and industrial power problems.

When you need *long-term, dependable* power, consult Nordberg . . . builders of America's largest line of heavy duty engines, including Diesel, Duafuel® and Spark-Ignition Gas types.

Nordberg Mfg. Co., Milwaukee, Wisconsin.

●

Installation Data . . .

1940—Installed Nordberg 3,000 hp Diesel, rated 2,000 kw.

1942—Installed second Nordberg 3,000 hp, 2,000 kw Diesel.

1951—Installed third Nordberg Diesel . . . a 10-cylinder unit rated 4,250 horsepower, 3,000 kilowatts.

NORDBERG

DIESEL • DUAFUEL® AND SPARK IGNITION GAS ENGINES

© 1957, Nordberg Mfg. Co.

P957

Multiple-bend discharge tube for refrigeration compressor is fabricated economically on Bundy-designed fixtures. Seven bends are put into a 7" length of ¼ x .028" Bundyweld Tubing in just one semi-automatic operation.

7 BENDS IN 7 INCHES

Only Bundyweld Tubing could take the stress ...only Bundy could mass-produce the part!

This refrigeration-compressor discharge tube graphically illustrates the unique physical properties of Bundyweld® Tubing . . . and the skill of Bundy® fabrication experts.

Seven bends in just seven inches sets up terrific stresses—too many for ordinary tubing. Yet Bundyweld takes this punishment with ease . . . still stays *leakproof by test!*

Because Bundyweld is double-walled from a single *steel* strip, it's extra-tough . . . has high bursting strength and great resistance to vibration-fatigue. Result: Bundyweld has become the standard of the refrigeration industry; and it's also used on 95% of today's cars, in an average of 20 applications each.

See what you can do with Bundyweld Tubing! Our engineers will help out at any design-stage in the development of your product, from blueprint to assembly. In many cases, they'll have suggestions on how to make a part faster . . . or at lower cost.

And when the design is firmed up, turn it over to Bundy's skilled fabricators and relax. Using Bundy-designed machines and fixtures, they will mass-produce your parts at low unit-cost. Then they'll package your parts carefully . . . deliver them right on schedule — clean, bright and ready to use.

Whatever your tubing needs, Bundyweld Tubing and Bundy services can pay off for you. Find out more. Call, write or wire today!

BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY

Bundyweld starts as a single strip of copper-coated steel. Then it's

. . . continuously rolled twice around laterally into a tube of uniform thickness and passed

through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

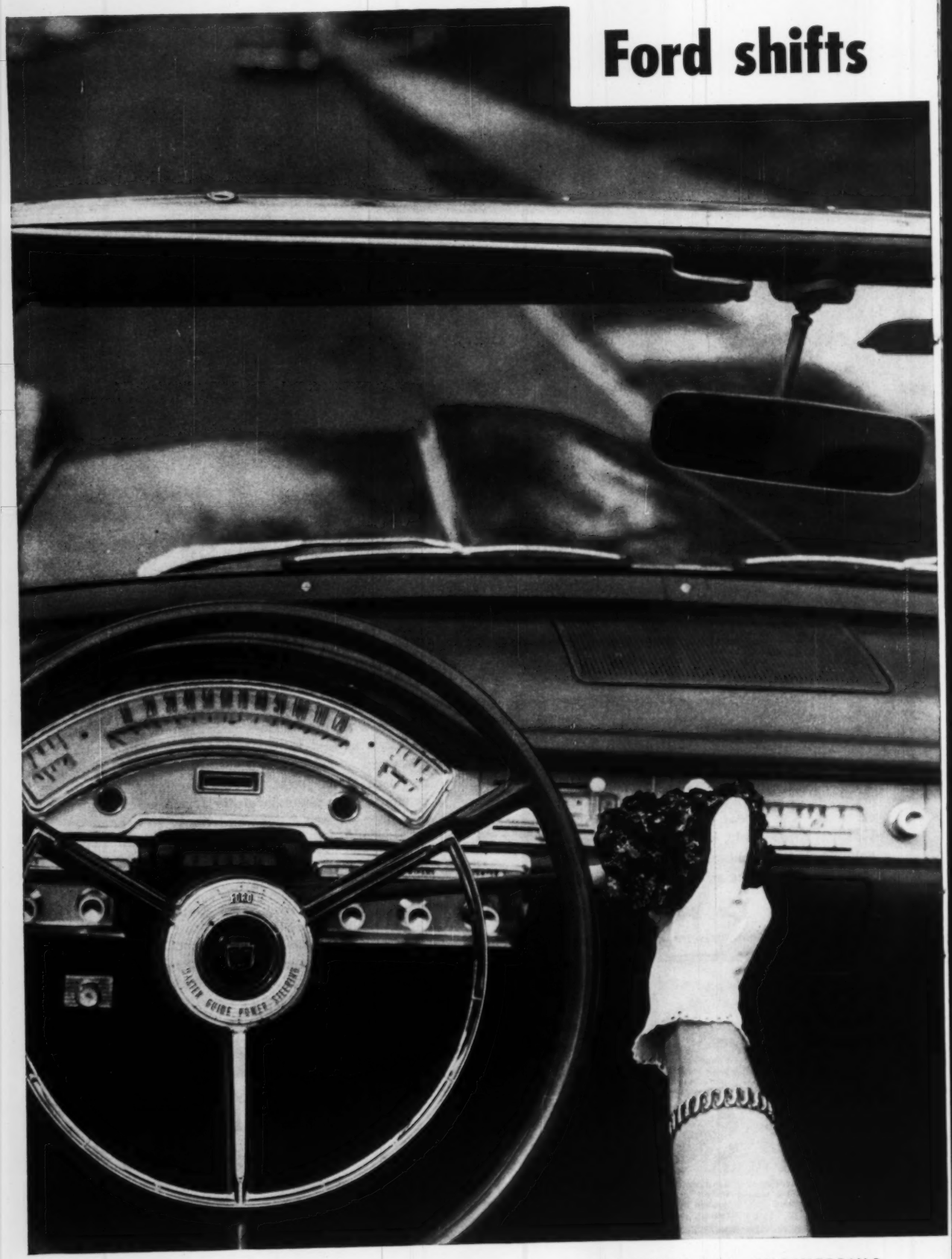
NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

THERE IS NO REAL SUBSTITUTE FOR

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP

Ford shifts



to coal for low-cost steam

Coal proves economical and easily available for steam generation at Ford's Louisville plant

Assembly Plant #2, Ford Division—Ford Motor Company, Louisville, Ky., was constructed in 1954. Because of the importance of steam for process work and heating, Ford's engineering department—working with the consulting firm of Albert Kahn Associated Architects and Engineers, of Detroit—conducted a fuel survey before the power house was designed. Object: to find an economical and efficient fuel.

Result: *coal* is used because of its *continuous* plentiful supply and advantageous price. Today this advanced coal-burning installation produces a reliable supply of low-cost steam. Only routine maintenance has been required and the cleanliness and general efficiency of this steam plant are considered among the outstanding features of its operation.

Facts you should know about coal

You'll find that bituminous coal is not only the lowest-cost fuel in most industrial areas, as in the case of Ford's Louisville plant, but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment can pare labor costs and eliminate smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with industrial fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case history booklet, complete with data sheets. You'll find it informative.

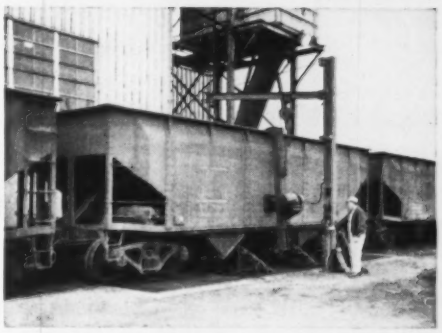
Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

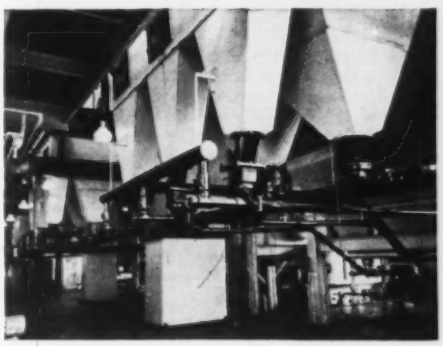
Dept. ME-06, Southern Building, Washington 5, D.C.

Firing aisle, shows Boiler #1 in right foreground. This is 60,000 lb/hr unit, using a two unit spreader stoker; Boilers #2 and #3 have capacity of 120,000 lb/hr and use four feeders. All three boilers are by Wickes Boiler Co., Type R, operating at 125 psi, 350 degrees F, fired by American Engineering "Perfect Spread" stokers.



Showing National Car Shaker being used to expedite emptying of cars. Dustless ash removal system in background.

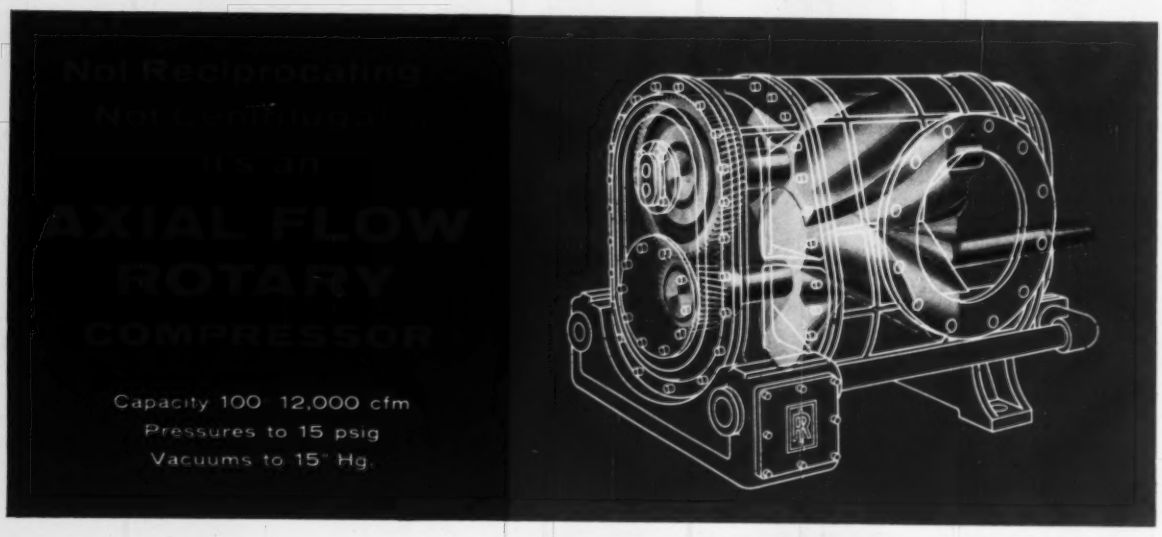
Beaumont Birch Steam Vacuum System draws ashes through pipes to outside ash silo for removal. View is at basement level, below boiler room floor. Coal handling system also by Beaumont Birch Co.



Mechanical dust collectors are by Prat-Daniel Corp. Fly ash handling system removes ash from collectors and boiler passes.

IN A CLASS BY ITSELF...

the Axi-compressor



BECAUSE of its unique rotary design, the Ingersoll-Rand *Axi-compressor* delivers air or gas with less power in a smaller space than other types of compressor of equivalent capacity. It is equally suitable for pressure, vacuum or combination operation.

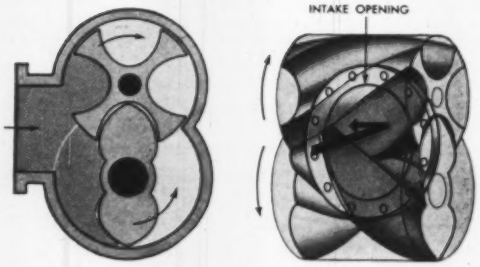
Utilizing the axial flow, positive displacement principle, the Axi-compressor discharges air smoothly and continuously, free from shocks. There are no pistons or valves, and the only moving parts are two perfectly balanced helical rotors which operate with minimum noise or vibration. The rotors never touch each other or the casing. Hence there's no need for internal lubrication.

Advantages:

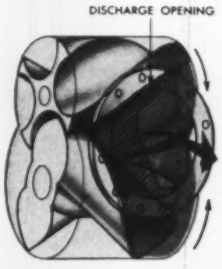
- **Space-Saving, Compact Design** – can be installed on simple, low-cost foundations.
- **Clean, Oil-Free Air** – no danger of contamination from lubricants.
- **Smooth, Pulsation-Free Compression** – no bulky air receivers required.
- **Operates at Higher Motor Speeds** – can be direct driven without belts or gears.

Ask your Ingersoll-Rand representative for complete information. Or send today for a copy of Bulletin 11,001A.

HERE'S HOW IT WORKS...



Intake: During the inlet cycle rotors are turning away from each other, drawing air or gas into the inlet space. This gas is then moved around to the discharge side of the compressor.



Compression and Discharge: During the discharge cycle the rotors are turning toward each other. They displace the inlet volume and air is smoothly compressed and forced axially toward the discharge opening.

Ingersoll-Rand

17-847 11 Broadway, New York 4, N. Y.

PUMPS • CENTRIFUGAL & RECIPROCATING COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • STEAM CONDENSERS

Why a Steam Trap Has to Handle "Air"

Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

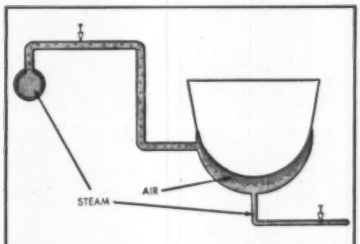


Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

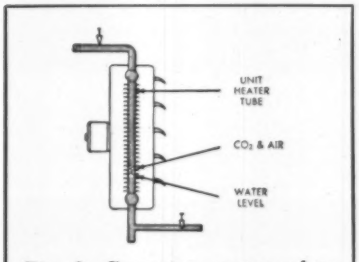


Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both, at steam temperature, as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. CO_2 gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. O_2 aggravates the situation. See Figure 2.

TABLE A—How air reduces steam temperature.

Gauge Pressure	Temp. of Steam with No Air Present	Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume)	
		10%	30%
10.3	240.1	234.3	220.9
25.3	267.3	261.0	246.4
50.3	298.0	291.0	275.1
75.3	320.3	312.9	295.9
100.3	338.1	330.3	312.4

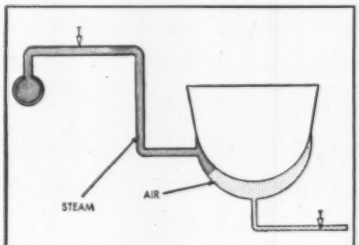


Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

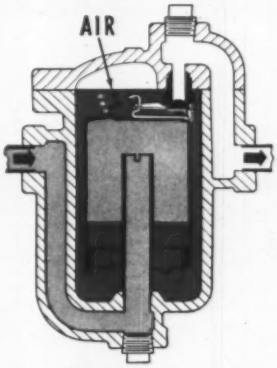
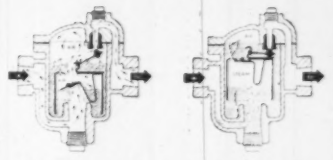


Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



Thermostatic vent open. *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

Open Float with Thermostatic Vent

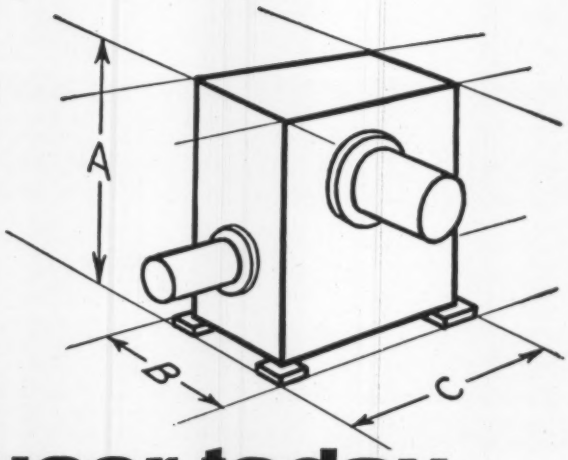
Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8943 Maple Street, Three Rivers, Michigan.

ARMSTRONG STEAM TRAPS

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

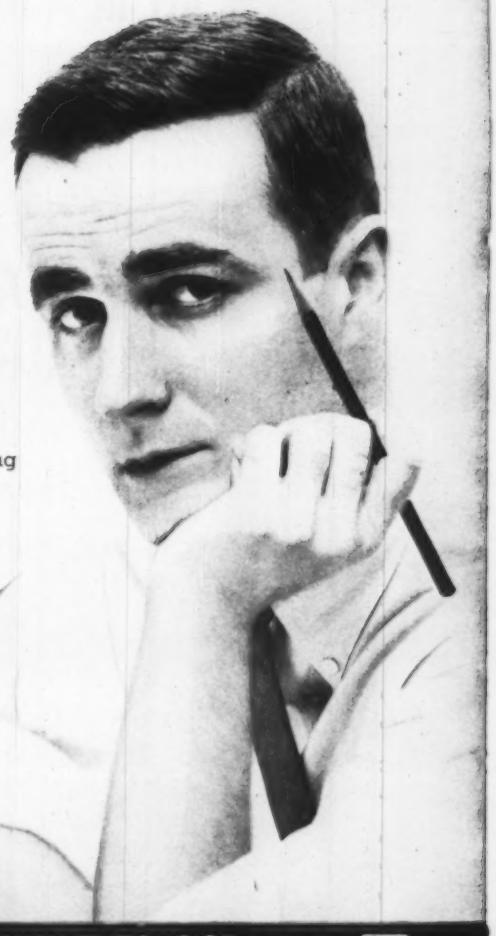
Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

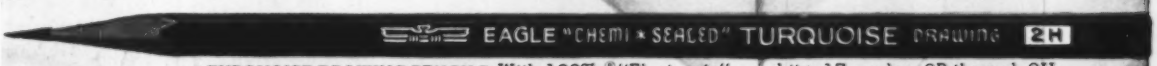
Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

are your **plans** as precise as your **planning?**



The proof of the planning is in the finished plans. That's why you're smart to use Eagle TURQUOISE —the pencil that tops 'em all for reproduction. Look what it gives you: Uniform grading (17 scientific formulas guarantee exactly the blackness you want —from every pencil, every time!). A strong non-crumbling needle point that stays sharp for line after long line of unchanging width. Inimitable smoothness —thanks to Eagle's exclusive "Electronic" graphite—TURQUOISE makes your plans look sharp—and you, too!

WRITE FOR FREE SAMPLE: Turquoise wood pencil and Cleantex Eraser, naming this magazine—or buy any of these drawing instruments from your favorite dealer.



• **TURQUOISE DRAWING PENCILS:** With 100% ®"Electronic" graphite. 17 grades, 6B through 9H.

• **TURQUOISE CLEANTEX ERASER:** Super-soft, non-abrasive rubber.

• **TURQUOISE DRAWING LEADS:** Fit any standard holder. Grades 5B through 9H.

• **TURQUOISE LEAD HOLDERS:** Hold any grade of Turquoise lead—so firmly that lead cannot be pressed back.

EAGLE® TURQUOISE

PENCILS, LEADS AND HOLDERS

are the largest-selling in the United States!

EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY • BOGOTA

ALL IN A DAY'S WORK at Pittsburgh Piping

STAINLESS STEEL AUTOCLAVE and VOLUTE
Shop Fabricated

by Pittsburgh Piping

This autoclave and volute assembly is typical of the work that goes through Pittsburgh Piping shops. Fabricated of Type 304 Stainless Steel, it is complex in design and is built for high pressure, high temperature service. This type of fabricating is a "natural" for Pittsburgh Piping. We pioneered the application of austenitic steel piping materials for central stations operating at 1050°F. and above, and fabricated the piping for the world's first atomic-powered submarine and central station. Highly specialized methods, machines, and apparatus have been developed and are employed in this work. Use them on your high temperature, high pressure piping jobs.

WRITE FOR YOUR COPY

This bulletin reports an intensive investigation into the problem of main steam piping materials and gives data on the stress rupture characteristics of Types 316 and 347 stainless steel piping adjacent to welded joints.

Promoting Progress ***IN POWER AND PROCESS PIPING***

Pittsburgh Piping AND EQUIPMENT COMPANY
158 49th Street—Pittsburgh, Pa.

Canada: **CANADIAN PITTSBURGH PIPING, LTD.**, 68 YONGE ST., TORONTO, ONTARIO

Atlanta . . . . . *Whitehead Building* *Cleveland* . . . . . *Public Square Building*
Chicago . . . . . *Peoples Gas Building* *New Orleans* . . . . . *P. O. Box 74*
New York . . . . . *Woolworth Building*

PP-32

Designing that special drive you need is second nature to Farrel engineers

Pictured are gear drives specially designed by Farrel for two of the company's own products. Both are "specials" engineered to meet customers' requirements for these applications.

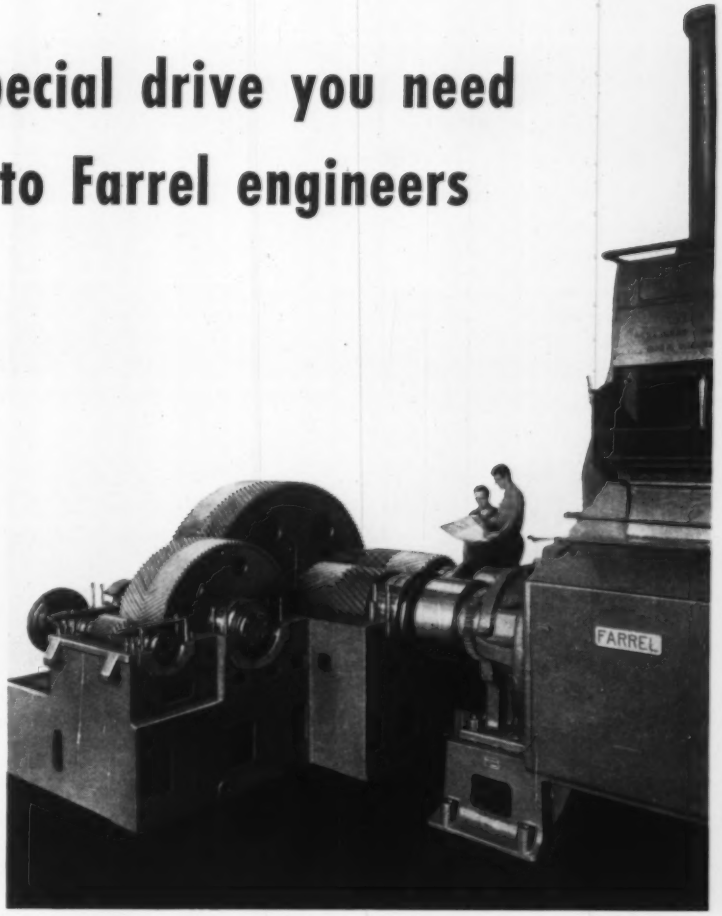
This kind of experience – year in and year out – qualifies Farrel engineers to design the "special" you may need; or perhaps the drive that will exactly suit your requirements is already among the hundreds and hundreds of units which have been developed by the company for use in the rubber, plastics, paper, sugar, marine and metalworking industries. The possibility is worth investigating.

The company's Buffalo plant has specialized for many years in the manufacture of gears, gear units and gear-generating machines. This specialization, coupled with the broad knowledge of industry requirements, is a hard combination to beat when you need a "special" gear drive.

Send for descriptive bulletins of Farrel gear units.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Boston, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Baton Rouge, Fayetteville (N.C.).
European Office: Piazza della Republica 32, Milano, Italy

Farrel-Birmingham®



2250 HP UNI-DRIVE
largest drive ever applied to a Banbury® mixer. Gears are generated by the Farrel-Sykes method – a process that assures accuracy of tooth spacing, profile and helix angle.

DOUBLE-REDUCTION GEAR UNIT
one of six specially designed for driving a six-mill tandem for grinding sugar cane. The girl is turning the drive by hand to illustrate the fine precision and balance of the huge double-helical gears mounted on antifriction roller bearings.

FB-1133

N. Y. Daily News Photo

New York's famous Coney Island boardwalk has undergone many changes in the last 35 years, but its old-time lampposts remain.

Corrosion-resisting Monel fastenings have held Coney Island lampposts securely for a generation.

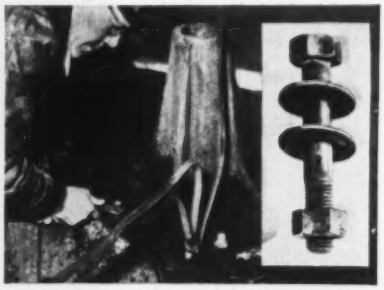
35 years in salt and storm throw light on a common fastening problem

One of the lampposts on Coney Island's boardwalk was taken down recently . . . Inside its base, a three-inch layer of rust flakes. Under the rust, four Monel* nickel-copper alloy bolts and nuts, holding the post tightly to the boards.

Threads were as clean and sharp as new. An easy twist with a pliers, and out came each Monel fastening — as fit as the day it had been put in! (see photo at right)

Salt corrosion is just one of the tough operating conditions Inco Nickel Alloy fastenings and other parts meet successfully. They do outstanding service under conditions of cyclic stress . . . high and low temperature . . . acid, alkaline attack. Selecting a metal to overcome conditions like these? Get Inco's handy guide — "Standard Alloys for Special Problems" — yours for the asking. *Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.



Bolt, nut, washers are still in excellent shape, little corroded after their long service.

INCO NICKEL ALLOYS

NICKEL ALLOYS PERFORM BETTER LONGER

MECHANICAL ENGINEERING

VOLUME 80 • NUMBER 6 • JUNE, 1958

Dollars for Unity

It's 1960. And on United Nations Plaza in New York City stands the newly completed United Engineering Center. It is an imposing 20-story structure symbolizing the strength and unity of the engineering profession. For the five Founder Societies, it is home. In addition, the Center houses some 15 other national engineering groups. An important facility included is the Engineering Societies Library, long recognized as containing the most outstanding collection of general engineering literature in the world. Now, located in the new Center, the Library, with its additional space and modern equipment, is providing an even more useful function for the profession, particularly since a major portion of the Library's service is provided through the mail. In its new conference rooms, society committees are already gathering to perform the important work so necessary to carry on the wide variety of engineering societies activities.

But, alas, it's really only 1958. All this day dreaming is about a new building which now exists only on paper. However, the dream has substance in the sense that plans for construction of the Center have been formulated. The site has been purchased opposite the United Nations Building. Architects, mechanical engineers, structural engineers have been appointed. One thing is lacking—money—money to make this dream a reality.

It is estimated that the entire project will cost $10 million. These funds are being allocated as follows: $2 million from United Engineering Trustees, Inc., $5 million from business and industry, and $3 million from individual members of the various societies. Of this $3 million, ASME's quota is $800,000. Thus the Society must engage in a major fund-raising venture to meet its share of the cost.

The ASME Member Gifts Campaign Committee is composed of W. F. Ryan, chairman; F. L. Bradley, vice-chairman; and the eight ASME Regional vice-presidents. Chairman Ryan kicked off the ASME campaign last month in a letter circulated to each member of the Society. This was the initial step. In addition, the plan of operation, through Section committees, calls for a personal approach to each member. Payments of pledges may be made over a period of three years and are tax-deductible. The campaign will be concluded on Nov. 15, 1958.

Thus a United Engineering Center can become a reality in 1960—if every engineer does his part. No greater evidence of unity in the profession can be shown than a list of contributors which includes every member of the Founder Societies. The size of the individual gift, of course, is less important than the number of contributors.

For the young man, a contribution will be an investment in the future of his career.

For the older engineer, a gift will repay part of his debt to the past and will be a tribute to the benefits and satisfactions he has derived as a member of the engineering profession.

When a campaign worker calls on you, remember that a contribution made to the new Center is a "once-in-a-lifetime" opportunity to support the most significant project the profession has undertaken in our time.

Your dollars contributed for this great project will provide an Engineering Center for you with a worthy purpose—efficient, effective, economical service to all engineers. At the same time it will pave the road toward strength and unity of the engineering profession.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.
Editor Emeritus, GEORGE A. STETSON

By R. L. Roemer,[1] Grumman Aircraft Engineering Corporation, Bethpage, N. Y.

With the jet era, the mechanical designer accepted a large share of the responsibility for adequate flying controls. Surface hinge moments demanded fully powered systems. The hardware designer worked with the analysts to provide a new set of system qualities, such as feedback ratio, structural compensation, and servo valve flow-stroke characteristics. Little attention was paid to improvement of mechanical linkage systems.

Now, the old design philosophies have had to be re-examined. All Grumman designs within the past two years have incorporated the policies described in this paper, and the results are evident in the primary flight-control systems of the F11F-1 and F11F-1F airplanes. The systems have been classed as outstanding by pilots who have flown these models.

Definition

There are three types of flight control: The manual system, in which the pilot actuates the primary control surface through a set of reversible mechanical linkages; the power-boosted system, also reversible, but with pilot effort boosted by a power source; the power-operated system, wherein the pilot provides the positional signal to an irreversible powered servo loop which actuates the surface. The objective, here, is to present factors involved in the design of the mechanical linkage, as used in all three types (Fig. 1).

Mechanical linkage may be any combination of cables, push rods, torque tubes, pulleys, sectors, drums, bell cranks, idlers, and horns. The manner in which these elements are selected and assembled into a workable system is influenced by the class of the airplane, the methods of construction, the type of control system, the opinions of the responsible designer, and the sympathies of the project management. The last two items are perhaps the most important in their over-all effects on the attainment of good control systems.

The ultimate goal is the attainment of adequate flying qualities. Specifically, the task is to provide precise control over the airplane's flight path, and to provide the pilot with satisfactory control force, or feel characteristics. It is essential to be able to trim the airplane to maintain desired flight attitudes or maneuvers with no control forces. In reversible systems, the airloads on the surfaces which produce control forces can be balanced at the desired position by means of adjustable trailing edge tabs. Fully powered systems, being irreversible, will not respond to air loads, therefore centering forces must be provided by springs. Trim is accomplished by repositioning the neutral position of the springs.

Forces on the Stick

Whether the forces which the pilot encounters in maneuvering the airplane are the result of the aerodynamic hinge moments on the surface or are produced by artificial means, their magnitude must be related to the maneuver being performed. The force gradients, or the force per unit of maneuver, must fall within practical limits. For instance, steady-state force gradients for the pitch-control system may be as low as 3 lb per g for a fighter-type airplane, or as high as 50 to 60 per g for a transport. The optimum gradient is a function of the airplane and its maneuvering limit.

[1] Controls Systems Group Leader.

Contributed by the Aviation Division and presented at the Joint Aviation Conference, Dallas, Texas, March 17–20, 1958, of The American Society of Mechanical Engineers and the American Rocket Society. ASME Paper No. 58—AV-4.

Far left:
We are long past the era of: "Stick in a pulley if something gets in your way." Well-designed linkages carry the message to the control surface.

Right:
Can the pilot "feel" the controls? Here, a cam and spring apply "artificial feel" to the rods in a powered—irreversible—control system.

Boosted and power-operated controls hold the stage; but the mechanical linkages are still there, still basic. Here are sound techniques and philosophies for aircraft flight controls.

In powered pitch-control systems, centering springs which provide a fixed relationship between force and system deflection from neutral cannot adequately provide force proportional to maneuver as flight conditions vary. There are several force-producing devices which will satisfy this requirement. Frequently bob weights are used to provide forces proportional to the pitching and normal accelerations developed. If the spring rate is varied in proportion to dynamic air pressure, the centering spring can be made to satisfy the force requirements throughout the speed and altitude range of the airplane. The design of artificial feel systems is an art too extensive to be taken up in this paper.

Handling characteristics are also influenced by the gearing, or mechanical advantage, between the cockpit controls and the surfaces. Motions of the cockpit controls are limited to ranges which are comfortable to the pilot. Motions of the hand on a control stick or column are restricted to no more than 14 in. in a fore-and-aft direction, 14 in. total side-to-side stick motion, or 180 deg of wheel rotation. Foot-pedal motions are limited to about $3\frac{1}{2}$ in. forward from neutral. The maximum surface travels are dictated by the maneuvering requirements of the airplane.

To lessen control sensitivity, nonlinear gearing may be used so that cockpit-control motion is greater, per unit of surface travel, near the center than at extremes.

Mechanical Disadvantage

Mechanical deficiencies which detract from a good system are weight, inertia, friction, slop, and flexibility.

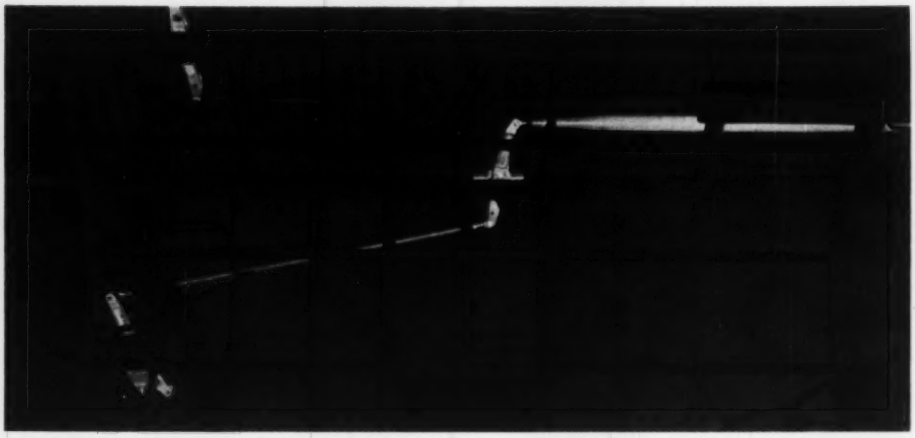
Weight. Any part is overweight when it is heavier than it need be to perform its required function for the design life of the airplane.

Inertia. Inertia, which is directly related to weight, has a more direct bearing on the proper functioning of a system. The allowable inertia depends upon the type of system. The maximum limit in a manual system is the amount which the pilot will tolerate; however, quite frequently a much lower maximum allowable inertia is dictated by control-system stability. In power-boosted systems, the inertia and flexibility of the input linkage have a strong influence on the dynamic stability of the servo loop. If a fully powered control system contains an artificial feel system which responds to airplane maneuvers (i.e., bob weights), the natural frequency of the input system, which is a function of the inertia and the centering spring rate, might well be critical.

The inertia of the output side of a fully powered servo system, coupled with the flexibilities of the linkage and supporting structure, will have a strong influence on the stability of the system. However, the major portion of this inertia is contributed by the surface, and the designer has little control over it. Whatever linkage is located between the power actuator and the surface is designed purely on a required-strength basis, and the resulting weight and inertia is accepted as is.

Friction. Friction occurs at rotating joints, slip joints, or sliding elements such as bungees, in cable wrapped around pulleys or sectors, where flexing produces relative motion between strands and wires, or where cables or rods rub against guides.

The acceptability of a control system is particularly influenced by the mechanical characteristics around neutral. The accuracy with which a system can be trimmed without a centering preload is affected by friction. If absolute centering is required, it can be provided only by including a preload or breakout force in the centering



Input linkages: cables and push-rods, side by side, where each offers advantages. Friction levels, in terms of force at the stick grip, have been cut way down by careful engineering.

spring greater than the friction. The total force required to initiate motion is the sum of the friction and the spring preload.

The class of airplane and the particular system influence the maximum tolerable force. The breakout force of the directional control system can be much higher than that of the lateral or longitudinal systems, since leg muscles are much less sensitive to small forces than arm muscles. Experience has shown that in high-speed, high-performance type aircraft, the total breakout force in the pitch axis should under no circumstance exceed three lb, and should be even less for the side motions of the arm required in lateral control. However, even these relatively low figures are objectionable in the sensitive flight regimes. In each case, good centering must be balanced against lowest breakout force to determine the desirability of providing centering-spring preload. Obviously it would be difficult to produce acceptable characteristics around neutral with a system containing a high degree of friction.

In power-operated linkages the pilot does not feel this friction, and since it is only a minute portion of the total operating load, the effects can be ignored.

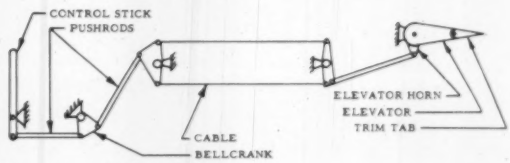
Backlash. The effects of slop differ in the various areas of a control system. In the manual linkage leading from the cockpit to the surface or feel spring, slop detracts from feel characteristics around neutral. Lost motion is as objectionable as breakout force. Pilots are apparently quite conscious of slop in the order of $^1/_{16}$ in. in a total travel of 14 in. for hand motions and $^1/_{16}$ in. in a total of 3 to 4 in. for foot motions.

In a powered system, slop between the centering spring and the power servo, and within the servo loop, detracts from the trimmability and positional accuracy. In the output linkage, between the servo actuator and the control surface, it reduces the restraint against flutter.

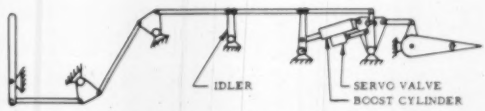
Slop exists in all moving joints. Even in ball bearings which are designed to provide low friction, radial clearance of from 0.0002 to 0.0004 must be provided so the balls will roll. In long systems there may be as many as ten or twelve push rods. Due to the ratio of stick motion to average push-rod motion, the total slop at the stick grip due to radial clearance in bearings alone may add up to $^1/_{32}$ in. or more. In closed-loop cable systems, rigging preload eliminates all slop within the cable loop.

Flexibility. Flexibility in a mechanical linkage is derived from two sources. One is the elastic deformation of the control linkage in the form of bending of arms, stretch of cables and rods, compression of push rods, and twisting of torque tubes. The other comes from the structure which supports the various elements. This flexibility is important when the support load and therefore deflection has a component in the direction of the control motion. For this reason idlers in a push-rod system, which serve only to provide intermediate support for long straight runs, contribute little to system flexibility. Bell cranks, on the other hand, change

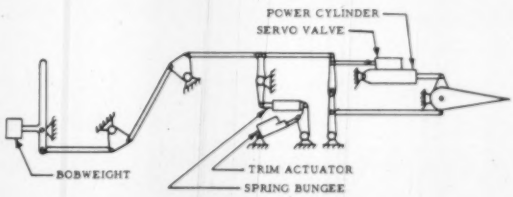
Fig. 1 Three basic types. Manual and boosted systems are reversible; fully powered systems require springs and/or bob weights to provide artificial feel.



MANUAL CONTROL SYSTEM



BOOSTED CONTROL SYSTEM



POWERED CONTROL SYSTEM

Pushrods and bearings on the output side of power cylinders take heavier loads. There should be a minimum of linkage between cylinder and control-surface horn.

direction of motion and load, resulting in a sizable support load and producing structural deflection.

Flexibility is the most maligned of all mechanical characteristics in control systems. It is often blamed for the results of a designer's oversight.

When establishing the gearing between the cockpit and the surface, or load-producing feel system devices, an allowance must be made for flexibility in order to insure full surface travel under load. In Fig. 2, the desired gearing to produce full surface throw for full stick throw is represented by curve *A*. If this curve were used to establish the system geometry, assuming rigid linkage, flexibility in actual operation would cause a loss of surface travel proportional to the load (curve *B*). However, if the flexibility had been taken into account, curve *C* would have been used for the no-load, design curve. In this manner when operating under load, the desired curve *A* would be obtained.

This same flexibility actually may have beneficial effects. Since the operating forces vary as a function of the maneuver and the required surface throw to produce a given maneuver varies according to the flight conditions, the control forces encountered with very little motion in sensitive flight regimes may be the same as or greater than those encountered for full throw under less sensitive conditions. The actual stretch of a given system is a direct function of the applied load. Therefore the stretch in the sensitive condition tends to increase the stick motion required to produce a maneuver by a greater percentage than in the conditions requiring full throw. This is represented by curve *D*. This effect is produced only in systems in which the device producing force proportional to maneuver is separated from the stick by an appreciable portion of the system or total flexibility.

However, flexibility coupled with breakout force results in cockpit control motion without corresponding surface motion which adds to slop in producing a control dead zone.

There are occasions when it is desirable to produce as stiff a system as practicable to prevent excessive load droop of a surface, to combat stability problems in boosted or powered systems, or to provide sufficient flutter restraint to aerodynamic surfaces. In any case, whether flexibility or stiffness is the desired characteristic, the existence of flexibility in all linkages must be acknowledged.

Fig. 2 The control designer must allow for flexibility both in the airframe and in the control linkages

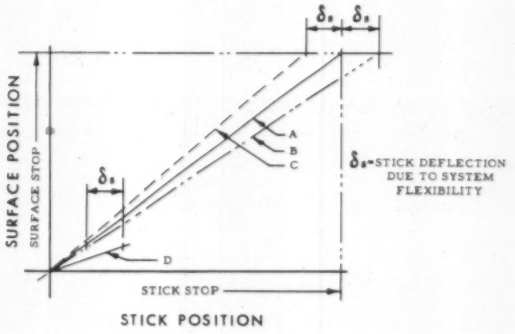
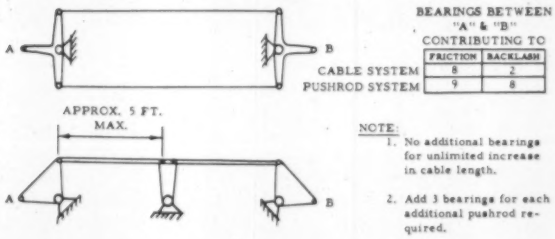


Fig. 3 Among the designer's basic decisions. Shall he use cables or rods? Both have their applications.



BEARINGS BETWEEN "A" & "B" CONTRIBUTING TO

	FRICTION	BACKLASH
CABLE SYSTEM	8	2
PUSHROD SYSTEM	9	8

NOTE:
1. No additional bearings for unlimited increase in cable length.
2. Add 3 bearings for each additional pushrod required.

Designing the System

To produce the best possible flight-control system the most important step is to attain top priority for the location of the control runs in any new airplane design. It is essential to begin locating the elements of the control system during the preliminary design phase. The paths selected should be the most direct possible, with a minimum number of changes of direction.

Avoid cams. Occasionally it appears that sensitivity

problems can be solved easily by using cams instead of nonlinear gearing. But the resulting friction can be excessive; or the slop can be appreciable when compared with the small output motions in the desensitized region.

Cables and rods. The choice between a push-rod system and a closed-loop cable system is generally made simultaneously with the selection of the system path.

In common cable systems, the major part of the total friction is contributed by operating the cable over pulleys. Cable size, pulley size, and operating load all have a bearing on the magnitude of friction. For this reason pulleys and sectors should be scrupulously avoided in primary control systems. Cables should be used only where relatively long straight runs are obtainable and should be attached to cranks at each end of the run. By virtue of the rigging, preload closed-loop cable systems have no backlash within the cable loop (Fig. 3). Over long runs a cable system may be much lighter and therefore have a much lower inertia than a push-rod system.

The maximum practical length of push rods is limited by allowable column length under compression loads, and by installation considerations. Long runs in this type of system are accomplished by using idlers for intermediate support. Since friction and slop are directly related to the number of joints, cable systems may also be more attractive from this point of view for long straight runs.

To change direction in a push-rod system requires the use of a bell crank, which introduces three rotating joints. On the other hand, to change direction in a closed cable system without pulleys requires a bell crank for both cables, resulting in six rotating joints. Therefore, when a system contains numerous changes in direction, pushrods should be used. In some cases it may be advantageous to combine cables and push rods in one system, using push rods in areas where directional changes are no further apart than the maximum practical push-rod length, and cables for the longer runs.

Since the coefficient of thermal expansion of steel is less than that of aluminum, the rigging preload of cable varies quite appreciably with temperature changes. Unless tension regulators are used, the preload must be high enough to prevent the cables from becoming slack at extremely low temperatures.

Rotating joints. All rotating joints in manually operated linkage systems should contain aircraft-type ball bearings. The joints between push rods and bell cranks or idlers should always contain self-aligning bearings, even though no misalignment may occur during operation. Deflection of the airframe in flight is sufficient to produce misalignments which would cause rigid bearings to bind.

Besides lower friction, there are less obvious advantages. The radial clearance in a ball bearing is less than the minimum which can be produced in a bushed joint. Most of the aircraft-type bearings are prelubricated and sealed and require no relubrication during their life. Plain bearings on the other hand must be frequently lubricated. Due to the tremendous mass production of these bearings for military aircraft they are, in general, quite inexpensive, and in many cases they can compete quite favorably with plain bushings from a cost standpoint.

Provide support for cables in areas where they might deflect against adjacent structure or equipment. Common practice is to use fair-leads, or rubbing strips of micarta. Clearance should prevent actual rubbing under normal conditions. In long lengths, the weight of the cable alone will cause it to sag appreciably unless supported. The use of low friction compounds (teflon), or roller-type fair-leads (small pulleys) would aid in reducing friction.

Only special close-tolerance bolts should be used in control linkage. In the most common sizes, the diameters are held to a total tolerance of 0.001 in. The holes reamed for these bolts should be held to a total tolerance of 0.001 so that the joint will contain from zero to 0.002 slop.

The output side. Linkage on the output side of a power actuator must necessarily be heavier than manually operated linkage since it is subjected to much higher loads than a pilot can apply. Actuators in boosted and powered systems should be located as close to the surfaces as possible, preferably driving directly on the surface horns. If an actuator must be located some distance from the surface, there are a few special problems to consider.

The magnitude of such loads makes push rods essential. They should be under tension for the highest loads. Stiffness is quite important in this area. Excessive load droop of a powered surface is undesirable because of the extra weight and power involved in providing sufficient actuator overtravel to compensate for linkage flexibility. It is also necessary to provide adequate restraint or mass balance about the surface hinge to prevent flutter under certain air-load conditions.

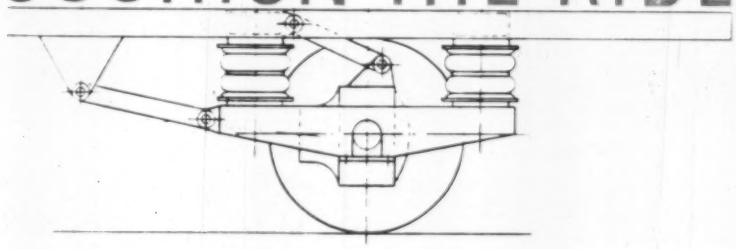
In linkages of this type rotating joints must operate properly under high loads. Frequently ball bearings cannot be used because of limitations in the load capacities in sizes which could fit the space. Spherical ball-type bushings can meet the high load requirements. These bearings will support static loads far in excess of the loads under which they will operate.

It has been found that, under very high loads when both the ball and outer race are made of steel, rotation will occur around the bolt instead of between the two parts of the bearing. When this occurs, the life of the joints is greatly diminished. This problem is greatly minimized if the outer race is made of bronze and a bearing size is selected with a static rating about three times the operating load. Self-aligning needle bearings can sometimes be used when space limitations prohibit the use of ball bearings.

Results

A comparison of the friction levels in the F11F systems with those in its predecessor, the F9F series, provides dramatic proof of the results which can be obtained. The friction in the longitudinal control system of the F11F is equivalent to three quarters of a pound at the stick grip. In the F9F-8 this same force is in excess of two pounds. In the lateral system the F11F has $\frac{1}{2}$ to $\frac{3}{4}$ lb of friction compared to $2\frac{1}{2}$ lb in the F9F-8. In the directional system, friction results in 3-lb pedal force in the F11F and nearly 9 lb in the F9F-8.

AIRSPRINGS CUSHION THE RIDE



Tried in the 1930's, the airspring had to await its time for automobile application. This report briefs the history and engineering of the air suspension.

By H. H. Deist,[1] Mem. ASME, The Firestone Tire & Rubber Company, Akron, Ohio

Airsprings date from the early 1930's. The original concept was to enclose the load-carrying column of air in a rubber-and-fabric container, following tire-construction principles, Fig. 1.

It was not adopted for automobiles in the 1930's because there remained room for tremendous development, at lower cost, in steel-spring suspensions. Also, the styling of that period did not demand the levelizing feature.

Air Replaces Steel

Firestone continued with airspring development work, and applications were made in other fields. Aircraft landing gears were developed, Fig. 2. Applications were made for shock and vibration isolators, pneumatic instruments, seat suspensions, valve operators, air brakes, gearshift vacuum boosters, welding machine actuators, tire building machine stitchers, and load cells. Trailer applications were made for Reynolds, Kuester, and Fairchild. In all, some fifty experimental airspring suspensions were installed on industrial trailers, railroad cars, motor coaches, passenger cars, and military vehicles.

The first rail car installation was made on a Pullman car in 1947. Since that time, several complete trains, such as the General Motors Aerotrain, the Pullman Standard Train X, and the Budd Pioneer III have been placed in operation. An excellent review of this progress in railway engineering is given in the February, 1957, issue of Mechanical Engineering, pp. 140–151.

In 1949, airspring-suspension jet-engine containers, Fig. 3, were manufactured in large quantities for the J-33, J-34, J-40, and J-47 engines. This was a unique application utilizing a small bellows inside of a larger one. The larger bellows, operating on air, handled the ordinary vibrations encountered during transportation. The smaller inner bellows filled with oil absorbed heavy transient-shock loads.

General Motors Coach now has over 400,000,000 miles of operating experience with airspring suspensions, and many of these individual airspring assemblies have run more than $^3/_4$ of a million miles without failure. In addition to improving the ride, the airspring has reduced suspension maintenance to the point where many bus operators no longer bother to keep records of it. Chassis and body maintenance also have been reduced.

Two or three years ago a passenger-car ride frequency of 60 to 70 cpm was considered venturesome. In today's planning, this range has become 40 to 55 cpm. Within the limitations of wheel-housing space, such soft suspensions can be obtained only by the use of nonlinear springs such as the airspring, Figs. 4 and 5.

Independent of Load

Natural frequency for a spring-mass system is inversely proportional to the square root of the static deflection.

The performance of a suspension, in so far as riding comfort is concerned, is generally measured in terms of natural frequency in cycles per minute (cpm) or in spring rate in pounds per inch of spring deflection. For linear springs such as coil or leaf springs, the spring rate is constant throughout the stroke and a single number describes the spring. For nonlinear springs such as airsprings, the spring rate changes throughout the stroke and both rate and position must be specified.

With a linear-spring system, the static deflection increases with load, therefore the suspension is very fast when the vehicle is lightly loaded and becomes slower (softer) when the load is increased. If the static deflection remains nearly the same for all load conditions, it follows that the natural frequency remains almost constant, and this is the case with the levelizing airspring suspension.

Ideal Performance

The ideal performance for a spring of given stroke is to provide as soft (low frequency) as desirable a rate in the range of stroke used most of the time, and still be able to absorb maximum energy in compression (jounce) without bottoming.

[1] Assistant Manager, Engineering Laboratories.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., Dec. 1–6, 1957, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 57—A-179.

AIRSPRINGS CUSHION THE RIDE

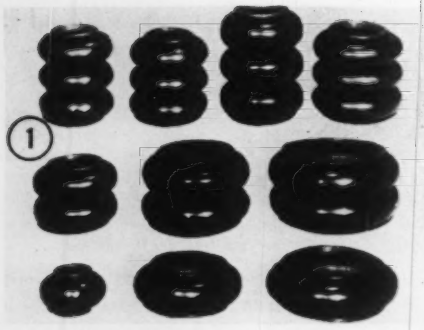


Fig. 1 Single, double, and triple-convolution bellows of various sizes. Though an early form, it has present-day applications. Wire beads in the ends provide for attachment.

Fig. 2 Airspring landing gear on a PY-19 training plane. Landing gears were also made for Wright Air Development Center, Stinson, Scott, Sikorsky, and the Navy.

Fig. 3 A 1949 development. Airpack prevented damage to jet engines during handling and transporting, by mounting the pressurized engine enclosure on airspring suspension.

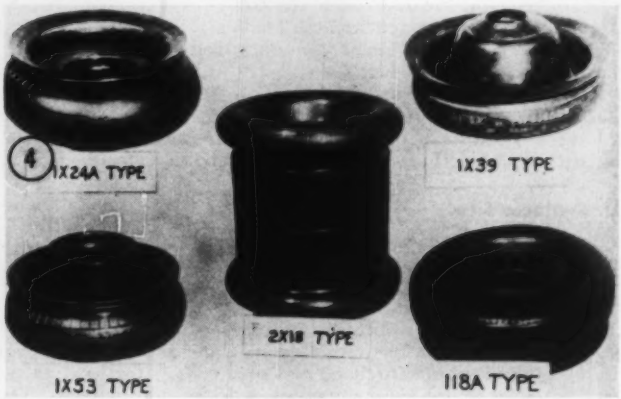
Fig. 4 Firestone 1X and 2X airsprings, for light and medium-weight vehicles, offering low frequencies with minimum reservoir size. The bellows has a small volume, yet permits long stroke.

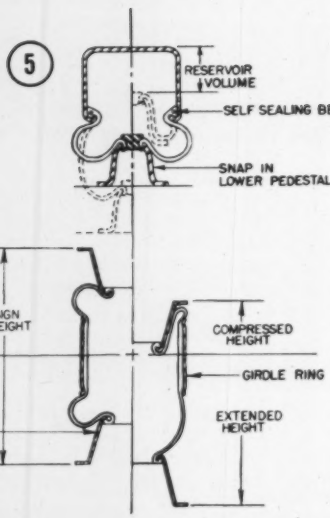
Fig. 5 Diagrams of the 1X bellows, *above*, and the 2X, *below*. The effective area can be made to decrease with compression to offset increasing air pressure, controlled by the shape of the lower attachment.

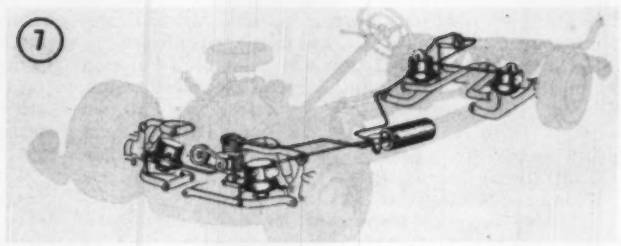
Fig. 6 Dynamic load-deflection characteristics of the airspring. While it is soft in the normal range, it becomes progressively stiffer when compressed, absorbing jounce energy without permitting the car body to strike through to the bump stops.

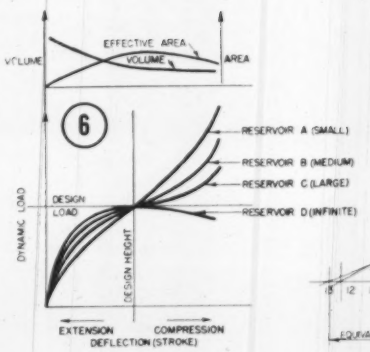
Fig. 7 Elementary air suspension system: An air compressor driven from the engine; a central air-supply tank; levelizing valves; reservoirs; airspring bellows; connecting piping.

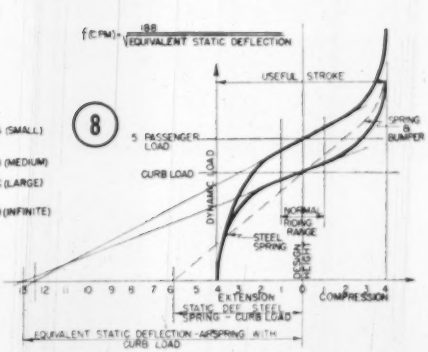
Fig. 8 Performance characteristics of 1X and 2X-type bellows. The effective area can best be determined by actual test measurement, but can be computed from layouts using theory.











The comparative performance of linear steel springs and optimum design airsprings is shown in Fig. 6. Here the airspring and steel spring are shown as having the same useful stroke and same design load and design height. However, the static deflection of the steel spring varies from 6 in. for curb load to 8 in. for five-passenger load. The levelizing airspring maintains nearly the same static deflection for any load and, by utilizing the flat portion of the curve for the normal ride range, a very large equivalent static deflection is obtained and, therefore, a ride of lower frequency. Thus the airspring provides a ride in the normally used portion equivalent to that produced by a linear spring having an actual stroke several times longer. Such a coil or leaf spring would, of course, be impractical.

The airspring has a different equivalent static deflection and, therefore, a different natural frequency, for each position of the stroke. This means that no resonant forced frequency can cause a large amplitude build-up. Thus the airspring has a form of nonenergy-consuming damping.

Levelizing

The elementary airspring-suspension system is shown in Fig. 7. The compressor and central reservoir are operated at a pressure higher than the pressure required for the airsprings under maximum load. Levelizing valves may be supplied for each wheel, or for each wheel in the rear with a single valve for the front end, or for each wheel in the front with a single valve for the rear end, or one valve for the front end and one valve for the rear end, or with a single valve for the entire vehicle.

The levelizing valves are intended to be static controls; that is, they adjust the body height only when the load is changed, and they remain unaffected by dynamic forces caused by bumps in the road, curves, turns, and other maneuvers of the vehicle. Two commonly used methods of accomplishing this are time-delay valves and unclutching or lockout valves.

In the first method, the valve is provided with a time delay of from 1 to 20-sec duration. The delay may be mechanical, pneumatic, or hydraulic. The time-delay length is selected so that it will be long enough that transient disturbances do not cause the valve to operate; yet short enough that the vehicle adjusts promptly to new load conditions. Unclutching or lockout valves are usually arranged so that they operate only when the vehicle is standing still or traveling at slow speeds. The valve lever is unclutched, or the air lines blocked when the car doors are shut, or when the engine runs at a certain rpm, or when the vehicle moves at a certain speed.

Another method is simply to orifice the valves so that air flow is small and allows the valve to operate continuously. This method is simple and inexpensive but is wasteful of air and slow to respond.

It is desirable to level the car body to within $^1/_4$ in. and the valves must therefore be very sensitive, with only a small dead zone. Rate of air flow is generally made to increase as the valve lever is displaced further.

Airspring Theory

The performance characteristics of an airspring are determined by two factors. The first is the expansion and compression of air as the bellows extends or compresses, and the second is the change in effective area throughout the total stroke. Since rubber is a good thermal insulator, the dynamic expansion and compression of the air is essentially adiabatic. The change in effective area is inherent in the design of the various types of airspring bellows.

Bellows volume. This is the internal volume of the bellows, exclusive of its reservoir, if any. This volume varies with stroke, being maximum for maximum bellows extension and decreasing to minimum at full compression. It is most useful to plot a curve of the bellows volume versus bellows stroke, Fig. 8. If possible, this information should be obtained from actual test measurements. However, if the bellows is not available, volumes can be computed from dimensions scaled from design layouts.

Reservoir volume. This is the volume external to the bellows when the bellows is in the fully compressed position.

Effective area. The effective area is the load-carrying area of the bellows. It varies with the stroke, being zero at maximum extension and generally maximum at design position. It is best presented in terms of a curve with effective area plotted against stroke, Fig. 8. At any position of the bellows, the effective area is equal to the load at that position divided by the air pressure at that position.

Design position. This is the position which the bellows will take under design load. Compression (jounce) and extension (rebound) are measured from the design position.

Design load. This is the load the bellows is normally expected to carry under static conditions. A vehicle may have several design loads, such as curb load and full load. Separate calculations are required for each condition.

Design pressure. This is design load divided by effective area at design position under static conditions.

(The author then presents relationship equations, tying together these and other variables. He lists the steps in a dynamic load-deflection computation.)

Generally, performance calculations are based upon a straight stroke. Many applications require the airspring to operate on an arcuate stroke in one or even two planes. While it is possible to make calculations for such conditions, the process becomes very time-consuming. Since it is desirable to obtain actual performance curves from test data in any case, the straight stroke calculations serve their purpose in initial evaluation of a design based upon desired load, stroke, air pressure, and reservoir-size criteria.

Theory must be backed up with both performance and endurance tests. Shapes which appear to be most desirable from theoretical considerations may prove to be unusable from the standpoint of manufacture, flexing life, performance, growth, burst, or stability.

New Directions

Although airsprings are presently being incorporated into conventional suspension designs, there is considerable activity under way to design new and novel suspensions around them in such a way that their advantages can be exploited to the fullest extent.

As a by-product of the air suspension, we may expect to see an increasing number of automotive components become air-operated. This may include such things as power brakes, power steering, windshield wipers, seat adjusters, and window actuators.

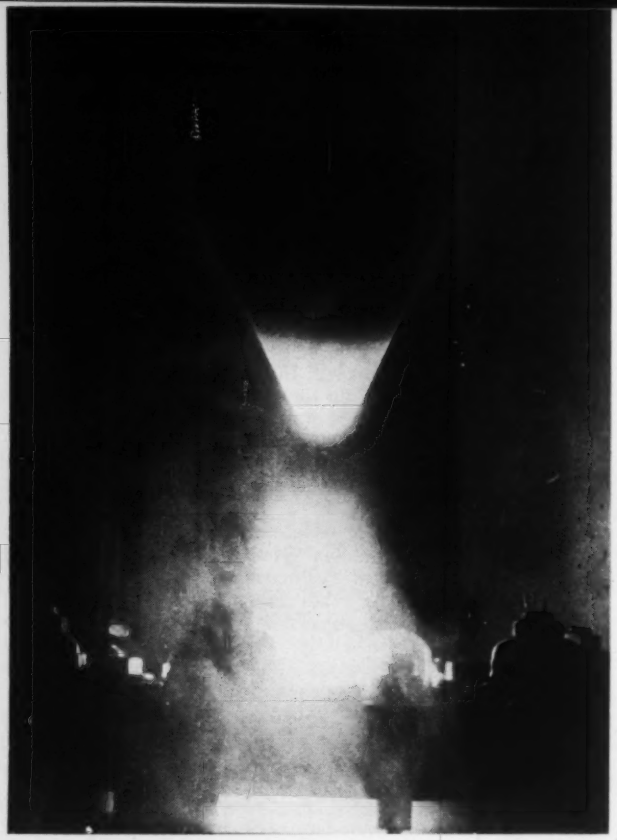


Fig. 1 A new research tool, currently being developed—the plasma jet, for high-temperature, high-heat-flux investigations. It is shown at Chicago Midway Laboratories. Developments in nuclear engineering and in satellites and missiles are demanding new achievements of the heat-transfer engineer.

A Review of HEAT TRANSFER Literature 1957

By E. R. G. Eckert,[1] Mem. ASME,
J. P. Hartnett,[1] Mem. ASME, and T. F. Irvine, Jr.[1]

The men who engineer the transmission of heat made headway in 1957. For nuclear power, for the new high-speed aviation, for the process industries, they moved into new areas of heat application and control.

THE year 1957 saw the first National Heat Transfer Conference, sponsored jointly by the ASME and the AIChE, held at Pennsylvania State University. While this was only one of many professional conferences dealing with heat transfer, it provided a forum for an exclusive and general discussion of the problems. It is planned to hold such a conference each year.

The International Conferences on Heat Transfer, the second of which will be held in the U. S. in the early 1960's, should promote exchange of pertinent information.

During 1957, a considerable number of books of interest in heat-transfer research were published (see Table 1 following References listed at end of the paper). Several textbooks became available either as new books or as new editions, among them a second volume of the late M. Jakob's "Heat Transfer."

Cooling problems encountered in satellites and missiles called forth research effort, directing attention to conditions of extreme speed and low density. Effects of dissociation and relaxation in high-temperature gases, of chemical reactions at surfaces or in the gas, of the interaction between mass and heat-transfer processes, and of the influence of catalytic or noncatalytic surfaces on heat-transfer rates have been closely scrutinized in a number of excellent theoretical papers. A new research tool currently being developed to study such high-temperature, high-heat-flux conditions, is the plasma jet, Fig. 1.

Developments in reactor engineering were responsible for an intensive research in boiling heat transfer and for a renewed interest in liquid metals as coolants. A symposium series [Table 1, no. 4] has been devoted almost exclusively to boiling processes. Heat transfer by radiation became important, and there were refinement and extension of calculation procedures which allow prediction of radiative energy exchange as influenced by geometry and radiation properties.

Cooling methods of interest for solution of the re-entry problem of missiles are based on physical processes which have been studied in connection with meteorological applications. These are natural convection flows under the influence of a constant body force, of rotation, of a magnetic field, or of superimposed radiation.

[1] Mechanical Engineering Department, University of Minnesota, Minneapolis, Minn. The authors acknowledge the assistance of Dr. P. J. Schneider, Missiles System Division, Lockheed Aircraft Corporation, Sunnyvale, Calif.

This report appeared first in the March, 1958, issue of *Industrial & Engineering Chemistry*, a publication of the American Chemical Society.

Conduction

Present-day engineering problems continue to stimulate new solutions to the Fourier conduction equation and the reporting of additional tabulations of existing solutions —particularly in problems associated with nuclear reactors, rocket power plants, and aerodynamic heating situations.

The time-dependent temperature distribution for a semi-infinite region, in which the thermal diffusivity varies with distance and the boundary temperature changes harmonically with time, is reported [4A].[2] Temperature fields in finite bodies under the influence of moving heat sources have been investigated [6A]. The method is used to study the finite plate and hollow cylinder under various boundary conditions. The same authors [19A] have also made an extensive investigation of heat conduction with time-variable boundary conditions.

The transient temperature field for a circular cylinder has been extensively studied [20A] with particular attention to cases where the boundaries are subjected to periodic variations in temperature. In an investigation of axially and centrally symmetric unsteady temperature fields produced by distributed volume and surface heat sources, and by heat exchange with the surrounding medium [11A], an example was presented of a cylinder under the influence of induction heating. Heat loss from a partially insulated solid body was studied [7A], where the uninsulated portion was losing heat by radiation to a medium at zero temperature. Two papers [16A, 8A] dealt with the technically important problem of the temperature field surrounding a buried pipe, presenting data not previously tabulated on the transient temperatures at individual points outside the cylinder and for the total heat flux crossing a unit surface up to any time.

Additional solutions have been published [14A] for a hollow cylinder initially at a uniform temperature which is subsequently maintained at the outer surface. The influence on heat conduction in a dielectric by an electric field has been analyzed [12A]. The study indicates that the action of the electric field is such as to increase the heat transmission, and the thermal conductivity increases as the square of the field voltage.

There is a technique [9A] which may increase the available conduction solutions involving a change of phase. Using the integral approach which has had considerable success in boundary-layer analysis, it is possible to obtain approximate solutions for cases where the exact solution has not yet been found. Another paper [3A] also deals with melting problems and moving boundaries. It is shown that an appropriate change of variable renders the boundary stationary at the expense of complicating the differential equation. Also, finite difference methods are investigated as applied to the melting problem.

Transient heat transfer in one-dimensional flow through porous media was studied without making the assumption that the gas and the solid are in thermal equilibrium [1A]. It is shown that the thermal equilibrium assumption is a reasonable one in many cases. General temperature distributions in porous structures are presented [17A] assuming that the fluid and solid temperatures are equal at every point within the wall. Both plane plates and circular tubes are considered, and the solutions include the effects of heat generation within the solid, the porosity of the wall material, and the convective conductances at both exposed surfaces.

Two articles [15A, 21A] are devoted to the equivalence of the equation describing the propagation of electromagnetic waves along cables with Fourier's equation for the propagation of heat through solids. The theorems which are classic with respect to the electromagnetic problem are examined for their implications in the thermal case.

A new set of finite difference equations for solving transient heat-conduction problems has been presented [5A]. The advantage of this alternate approach is that rapidly changing temperatures near a boundary need not require inconveniently short-time intervals to assure convergence. In a critical evaluation of the finite difference approach [18A] the relation between mesh size and final accuracy is examined, and the use of electronic computers for solving problems of this type is discussed.

Among conduction solutions, the effect on the temperature field in a front-heated slab of a small hole drilled in the surface was investigated [13A]. Calculations yield an estimate of the error incurred when the surface temperature is measured by means of a temperature transducer placed in the cavity. An investigation of the timewise temperature distribution occurring in food-canning processes was presented [10A]. Experimental measurements are compared with known solutions to determine the suitability of the theoretical model when applied to actual situations. The accuracy of transient techniques for heat-transfer measurements was investigated [2A]. When certain losses are neglected, significant errors can arise.

[2] Numbers in brackets designate References at end of paper.

Channel Flow

The desire to make heat-exchange equipment compact, and to increase the amount of heat transferred per unit of pumping power, has led to passage sizes such that laminar flow exists. Accordingly, laminar-flow calculations in the literature have taken on a new significance.

Combined forced and free laminar heat transfer in vertical tubes has been investigated [8B]. With the assumption of fully developed velocity and temperature profiles, Nusselt numbers and friction factors were calculated under conditions of uniform internal heat generation and constant heat input per unit length at the walls. A solution has appeared for circular duct heat transfer with slug flow and internal heat generation, when the fluid enters the duct with constant temperature, with the wall maintained at a different temperature [22B]. Unlike a previous solution, the longitudinal conduction is not neglected. A general discussion of laminar-flow heat transfer in tubes was presented [7B], in which experi-

mental data were reported for a fully developed fluid flowing upward under the conditions of constant heat input per unit length. An experimental study has been conducted on unsteady-state heat transfer to and from gases in laminar tube flow [17B].

The application of classical unsteady state conduction solutions to turbulent flow heat transfer in pipes, in annuli, and between parallel plates was studied [13B]. By treating the turbulent fluid as a series of composite slabs or cylinders, and by a rational adjustment of the inner slab boundary conditions, heat transfer was predicted for a variety of wall boundary conditions. The assumptions which appear in low Prandtl number turbulent heat-transfer calculations with respect to the eddy heat-transfer diffusivity were discussed [11B].

Another reanalysis [21B] of Nikuradse's classical pipe-flow velocity profiles results in a new expression for the universal velocity profile which shows no major deviations from the law commonly accepted. The influence of longitudinal temperature distribution on circular-tube heat transfer has been investigated [23B]. Eigenvalues have been calculated so that the heat flow can be determined to a constant-property turbulent fully developed fluid when the wall temperature has an arbitrary distribution in the flow direction.

Following experimental measurements of heat transfer to air in heated pipes at gas speeds up to 1.6 times that of sound [1B], it is concluded that conventional low-speed relations can be used to predict the heat transfer if corrections are applied for the effect of viscous dissipation. Another experimental investigation [20B] reported on the unsteady air temperatures at a tube exit when the duct walls act as a heat reservoir, and when the fluid, which has a timewise temperature variation at the tube entrance, is turbulent.

An investigation of the effect of roughness on heat transfer and friction [18B] used roughness elements which were holes and thus the inverse of the usual protuberances. Such elements offer the possibility of more definitely specifying the thermal boundary conditions. Friction measurements only were made, and they agreed with the work of previous investigators. In heat-transfer and friction measurements made with smooth and commercially rough pipes in a Reynolds number range from 10^4 to 8×10^4, results were correlated successfully by the use of the Martinelli equation. Recent investigations in rough-pipe pressure drop and heat transfer have been summarized [5B], covering the influences of corrosion and dirt deposits and the effect of particles in the fluid.

Analysis of the stability of fully developed laminar flow entering a curved channel [26B] led to the conclusion that secondary flows can be caused as much by curvature instability against Taylor-Görtler vortices as by the existence of the boundary layers to which the secondary flows are usually attributed. Complementary to this is an experimental investigation of secondary flows in ducts [9B]. By flow-visualization techniques it is shown that secondary flows can arise from the existence of boundary layers. An analysis has been presented [14B] for turbulent flow between rotating concentric cylinders and for two-dimensional turbulent flow in a curved channel.

Regarding flow of non-newtonian fluids through pipes, a theoretical and experimental investigation [15B] reports on the variables controlling heat-transfer rates in the laminar region. The theory is applicable to both newtonian and non-newtonian fluids. Another study [4B] has presented numerical solutions of the energy and flow equations for non-newtonian fluids through circular tubes, including the effects of viscosity and thermal-diffusivity variation with temperature, viscous dissipation, and cooling resulting from expansion. Experiments showed good agreement with the theory. An analysis [6B] predicts the temperature distribution and the Nusselt number for laminar flow for a viscous liquid whose friction law corresponds to the exponential equation of deWaele, and also for a paste as defined by Bingham. An equation in [12B] describes the laminar flow of a Bingham fluid through an annulus.

A method of increasing heat transfer without increasing area has been discussed [3B]. Experiments showed an appreciable increase in heat transfer to gases caused by the addition of solid particles to the gas stream. Two reports [10B, 16B] analyze the Couette flow of a viscous, compressible fluid. Such a flow has implications in bearing research. In an experimental determination of thermal entrance lengths for the flow of air and carbon dioxide in a circular tube [25B], the data agree well with the prediction from Deissler's analysis.

A problem of increasing importance is convection accompanied by large variations of the fluid physical properties. In an investigation of heat transfer to carbon dioxide near the critical point [2B], the large property variations were accounted for by following a procedure suggested by Deissler. Another investigation [19B] studied heat transfer to oxygen near the critical point. The authors did not give their results in a generalized form, but tabulated the data for investigators who may wish to make a further study.

Boundary Layer Flow

Laminar boundary layers. Considerable effort was directed toward solutions to the laminar boundary-layer equations. An exact solution of these equations for a fluid with constant properties and small Prandtl number (liquid metal), flowing over a flat plate with locally constant-surface temperature or with locally constant-surface heat flux, has been reported [27C]. Good agreement was obtained when the results were compared with approximate calculations using the integrated momentum and energy equations.

A procedure was proposed, to solve laminar boundary-layer equations when a temperature and velocity gradient normal to the surface exists in the main stream [13C]. Such conditions are found in the region between the shock wave and the surface on objects traveling with hypersonic velocities. Similarity solutions have been obtained for laminar boundary-layer flow of a compressible medium with variable properties under the following restrictions: Prandtl number equal to 1, viscosity proportional to absolute temperature, isothermal surface

and particular free-stream velocity variation leading to the similarity [5C]. These solutions have been used, together with the Stewartson transformation, to develop an approximate procedure to calculate local heat-transfer coefficients for surfaces with arbitrary pressure gradients [6C]. Measured local laminar heat-transfer coefficients have been reported [16C, 18C, 20C] for a sphere and a hemisphere, in good agreement with values obtained by calculations using integrated flow and energy equations. Measurements have also been made on a flat plate in a flow which, at a certain location, experiences a rapid acceleration up to four times the upstream velocity. Again, there is good agreement of measured laminar heat-transfer values with calculations using the integrated equations [26C].

In mass transfer from the naphthalene surface of hollow cylinders, arranged in axisymmetric flow of air, we have a relation for the dimensionless mass-transfer coefficient which contains the influence of cylinder radius [4C]. This effect was 0.4 to 6 per cent smaller than values calculated by Seban and Bond, and by Kelly.

Interest in flight at very high velocity stimulated a considerable number of papers on flow and heat transfer in a dissociating gas. The basic equations accounting for the dissociation effect in a simple diatomic gas have been developed [19C, 21C]. Extensive calculations of heat transfer at the stagnation point of a blunt body in dissociated air flow—which include the effect of diffusion of the various components (expressed by the Lewis number), equilibrium or frozen state in the boundary layer, and finite recombination rates at the surface—gave the following results: The heat flow per unit area to a catalytic surface has almost the same value, regardless of whether dissociation occurs in the boundary layer or at the surface, or not at all; on a noncatalytic surface, the heat flux was found in a specific sample to be only half of the value on a catalytic wall under otherwise comparable conditions [12C]. Fig. 2 compares the calculated heat-transfer coefficients with measurements obtained in a shock tube at AVCO Research Laboratories [21C]. Heat transfer at the stagnation point was also found to be well represented by the available relations for a constant-property fluid when the heat-transfer coefficient is based on enthalpy instead of temperature, and when the properties are introduced into these relations at a proper reference enthalpy [25C].

Laminar flow equations or boundary-layer equations were developed for a fluid in which chemical reactions occur either in the fluid itself or at the surface [1C, 3C, 9C, 15C, 31C]. Finite reaction rates were taken into account. Laminar mixing of two compressible fluid jets, with heat release by chemical reactions with finite reaction rates, is calculated for the condition that the two jets have the same temperature but different velocities, or the same velocity but different temperatures [24C].

Nonsteady conditions. The surface temperature of an adiabatic plate which oscillates in a fluid at rest increases continuously in time. This temperature is calculated, starting with an arbitrary temperature profile in the fluid at time zero, and is expressed as a dimensional recovery factor [22C]. A second paper treats a laminar steady boundary layer, on a flat plate, of a fluid with a viscosity proportional to the absolute temperature and a constant specific heat for the situation that the plate surface temperature changes with time [28C]. In a numerical example, in which the surface temperature is assumed to increase by 10 F per sec, the heat-transfer coefficient

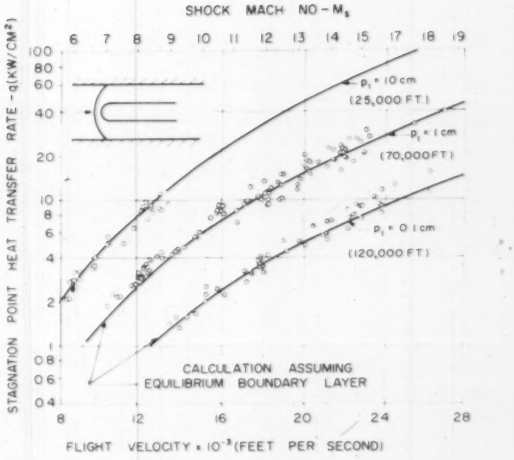


Fig. 2 Comparison: Hypersonic experimental stagnation-point heat-transfer results versus calculated heat-transfer coefficients (the calculations assumed equilibrium conditions). The measurements were obtained in a shock tube at AVCO Research Labs.

is found to differ by only 0.2 per cent from the corresponding quasi-steady value.

Turbulent boundary layers. Turbulent mixing of two hot-air jets has been investigated experimentally [29C]. Heat and mass transfer in laminar and turbulent boundary layers with an arbitrary surface temperature distribution, and for a stream velocity proportional to some power of the distance from the leading edge was calculated [7C]. Turbulent velocity and temperature profiles were measured on a flat plate downstream of a stepwise discontinuity in the wall temperature [17C]. The velocity and temperature profiles were not similar. Simplified equations have been developed which allow an approximate calculation of the local and total heat flux to nonisothermal surfaces [10C]. Simple relations which roughly approximate the actual conditions for heat transfer in the nozzles of rockets are of value, as physical processes involved in the flow of reacting and mixing gases at these high temperatures are only poorly understood [2C]. The properties of a turbulent "equilibrium" boundary layer can be theoretically derived, on the assumption of similarity and of an eddy viscosity which is independent of wall distance at the outer part of the boundary layer [30C]. Local coefficients of skin friction and heat transfer have also been measured for boundary layers in two dimensional diffusers [14C].

Transition to turbulence. A stability calculation for a laminar boundary layer near a stagnation point of an impermeable wall, and over a wall cooled by fluid injection, has been reported [23C]. Measurements on the transition process at a Mach number of 3.12 on a hollow cylinder or a cylinder-cone combination indicate that blunting of the nose as well as cooling of the surface generally increases the transition Reynolds number [8C]. For extreme cooling, however, the transition Reynolds number decreases very strongly again. Experiments on laminar separation of a flow at Mach 3 from the surface of a flat plate, caused by an incident shock or a spoiler, showed no influence of a heating or cooling of the plate surface in contradiction to theoretical predictions [11C].

Flow With Separated Regions

A correlation of available experimental data for convective heat transfer between gases and a cylinder in crossflow resulted in a single relation, for heating as well as for cooling, and for small and large temperature differences. The Reynolds number in this relation is expressed as diameter times upstream velocity divided by the kinematic viscosity, and this property and the heat conductivity in the Nusselt number are introduced at film temperature [2D]. Measurements on small cylinders in a gas stream of 2000 to 3400 R, at Mach numbers between 0.3 and 0.8, and at Reynolds numbers between 450 and 3000, could be expressed by the following equation: $Nu = 0.428\ Re$ with an accuracy of better than 1 per cent.

Properties were introduced at the total temperature in the stream [3D]. Heat transfer to wires in supersonic flow [8D] shows that the heat loss of the wire is independent of Mach number in the range 1.3 to 4.5. Experiments also indicate that the average heat transfer to a cylinder at subcritical and supercritical Reynolds numbers depends on the turbulence level in the stream [6D]. An increase in the turbulence intensity from 0.6 to 2.6 per cent increased the Nusselt number by approximately 15 per cent.

Heat transfer of mercury to a staggered tube bank with arrangement of the tubes in equilateral triangles at a Prandtl number 0.022 and in a Reynolds number range from 15,000 to 83,000, yielded information on local and average heat-transfer coefficients. These values differed, depending on whether the surface was wetting (copper) or nonwetting (chromium-plated copper) [4D]. Extensive measurements on average heat-transfer and friction factors for flow through woven-screen matrices and crossed-rod matrices have been made in a wide Reynolds number range and for porosities between 0.6 and 0.83 with two transient techniques [9D].

By experimental investigations [1D, 7D, 10D], relations have been obtained for the effective thermal conductivity in packed beds with a forced flow through the bed. It appears that a relation based on work by Ranz and Damkoehler represents these values satisfactorily. Local heat transfer within a fluidized bed to a hot-wire probe was measured for eight different gases [5D]. Conclusion: Particle to particle heat transfer in such a bed is extremely large.

Transfer Mechanism

Calculations on turbulent heat transfer to solid surfaces, based on a model which subdivides the flow regime into several regions, including a laminar sublayer, could not predict measured values satisfactorily at high Prandtl numbers. H. Reichardt [10E] used a law for the turbulent diffusivity which describes a continuous decrease of this value toward the wall, to calculate heat-transfer coefficients in a very wide range of Prandtl numbers including very small values. Several models have been used to obtain information on the transfer of energy in turbulent flow [1E, 6E, 11E], and on the transition to turbulence [5E]. Measurements of the eddy diffusivity for momentum and heat, and of the turbulent Prandtl number in a developed duct flow, have been continued. It was found that all parameters depend on wall distance and change considerably with Reynolds number [8E].

Velocity, temperature, and pressure distribution in a high velocity vortex flow have been calculated for laminar flow [9E] and determined by measurement in turbulent flow [7E]. The measurements have also been extended to a vortex tube in which fluids of high and low energy are separately discharged from the two tube ends [12E]. The various fields are reported for the condition that 50 per cent of the total air is removed at the cold tube end.

Calculations on a cylinder, with various angles of attack in a free molecular flow, resulted in relations for the temperature recovery factor and the Stanton number [13E]. The accommodation coefficient appears as parameter in these relations. The temperature which an adiabatic flat plate assumes, when it moves normal to its surface through a highly rarefied gas, has been measured by rotating the plate at the end of an arm in an evacuated chamber [3E].

The specific impulse of a rocket with solid particles in the gas stream depends considerably on the degree to which the energy is exchanged between solid and gas. A calculation was carried out on the basis of kinetic theory to determine this energy exchange for particles not larger than the mean free pass length of the gas [4E]. Some aspects of magneto hydrodynamics, important for gas flow at high temperatures, have been discussed [2E].

Natural Convection

An analytical solution for free convection from a heated vertical plate at very high Prandtl numbers has been obtained by dividing the boundary layer into two parts: In the immediate vicinity of the wall, the temperature boundary layer goes from the wall temperature down to the free stream value while the velocity is assumed to reach a maximum at the edge of this thermal layer; in the outer region at some distance from the plate, the velocity returns from a maximum value down to the value of zero [17F]. The isothermal vertical plate at normal Prandtl numbers (air) has been used by Bevans to determine, with the use of an interferometer, the effect of an unheated starting length and the influence of obstructions on the free-convective heat transfer [1F]. The heat transfer was reduced substantially in the region immediately in front of the blockage.

A recent paper [16F] attacks the problem of the isothermal vertical cylinder, showing that heat transfer from the cylinder is generally higher than that from a vertical plate, but also showing conditions under which

the differences are not substantial. Turbulent free convection in air over a heated horizontal plate in a large open space was experimentally determined and compared with the results obtained from a heated plate with a cooled upper boundary; no difference was found; the conclusion is that the heat transfer is dictated by conditions in the immediate vicinity of the heated surface [18F].

An experimental program reports the variation of the heat-transfer coefficient and surface temperature for an electrically heated cylinder at various angles of inclination ranging from horizontal to vertical [5F]. A horizontal right cylinder was used to study free convection in Freon-12 near the critical state, and a tenfold increase in performance is noted in this region [4F]. Classically, free convection to cylinders and spheres at very low Grashof numbers has been determined by assuming pure conduction; however, recent experimental results depart from such predictions. A possible explanation for this discrepancy is advanced by Mahony [9F].

Simultaneous heat and mass-transfer data from spheres of volatile substances have been reported [10F, 14F]. The dimensionless presentation of these results obtained by Mathers and his co-workers was suggested by solutions they obtained for simultaneous mass and heat transfer in free convection from a vertical plate [10F].

Free-convection in confined spaces has been studied experimentally for two parallel vertical plates [13F, 15F], for vertical tubes [7F], and for spheres [13F]. Siegel and Norris [15F] conducted experiments with two parallel heated vertical plates under the following conditions: Closed at the sides and bottom; closed at sides, open at bottom; open at sides, open at bottom; forced air flow by the top, plates closed at sides, open at the bottom. Experimental studies of free convection with water in a vertical tube with uniform heat flux are compared with earlier results for the constant wall temperature boundary condition, and it appears that the average heat-transfer performance is equivalent for these two conditions [7F]. Transient free convection to a number of different fluids enclosed in a spherical vessel was determined [13F] and an indication of the internal flow patterns was obtained by photographing the flow field inside heated horizontal cylinders.

Free-convection studies in thin layers heated from below are reported [2F, 6F, 11F, 12F]. An analytical study by Chandrasekhar treats the instability of a thin layer of liquid metal heated from below and subject to the simultaneous influence of rotation and a magnetic field [2F]. He concludes that the instability may set in as normal convection or as oscillations (overstability), depending on the dimensionless values of the rotation (Taylor number) and the magnetic field. A related experimental program utilizing mercury as the working fluid in the presence of a magnetic field demonstrated the stabilizing influence of such a field as predicted earlier by Chandrasekhar [11F].

For some thin layers of fluids and gases heated from below, the influence of thermal radiation on the onset of convection may be significant. Two limiting cases where the enclosed layer is considered to be either opaque or transparent while the two horizontal surfaces are considered to be black bodies were treated analytically [6F].

The thermal instability of a rotating spherical mass with internal heating is studied [3F]; a somewhat similar problem of a rotating annulus of fluid cooled on the inside wall and heated on the outer wall is analyzed and the instability limits are presented [8F]. The equations governing the unusual but important geological problem of free convection in permeable solid materials, as found in geothermal regions, are developed, and approximate solutions yielding the flow field and temperature distributions for a particular situation are reported [19F].

Transpiration Cooling

The influence of mass addition on velocity and temperature profiles in the boundary layer can be studied by solution of the constant-property laminar boundary-layer equations. Such solutions are reported for steady flow over a flat plate and in the vicinity of a plane stagnation point [3G]. For both flow situations, the heat transfer and skin friction are significantly reduced by small amounts of mass addition.

A related unsteady problem wherein a flat plate of infinite extent is suddenly set in motion, with mass being injected from the surface of the plate, is treated by Hasimoto. The results demonstrate the same traits as the steady boundary layer [4G]. A recently declassified report presents experimental results for the transpiration cooling of a flat plate at a Mach number of 2.7 using air as the coolant; reductions in the heat flow of as much as 55 per cent with transpiration cooling are reported [9G].

If the mass transfer should occur from the surface of a liquid, the tangential velocity at the surface may be finite: A recent theoretical analysis reveals the influence of such a nonzero velocity [10G]. A similar problem, wherein mass transfer occurs between cocurrent fluid streams, is solved by the integral method for small rates of mass transfer [7G]. The mass and heat-transfer rates from single spheres and cylinders at low Reynolds numbers have been determined by combining the proper Stokes stream function with the integral method: The experimental data are 10 to 40 per cent higher than predicted by the analysis [2G]. Another contribution reports an experimental investigation of the diffusion of mercury vapor from spheres into gas streams [5G]. Potter [7G] states that these mercury results agree well with boundary-layer theory.

The effect of mass addition on the hypersonic flow field over a flat plate is to thicken the boundary layer, causing the shock to move away from the surface and increasing the pressure on the plate above the value with no injection [12G]. The influence of variable physical properties on mass transfer may be determined by solution of the simple equations for Couette flow. Exact solutions for Couette flow with the injection of a foreign gas are available, and the resulting velocity, temperature, and concentration profiles are expressed in the form of simple integrals [6G].

Although transpiration cooling appears to offer a solution for high-speed vehicles and gas-turbine blades, the engineering difficulties of controlling the porosity may well eliminate porous surfaces from consideration. A recent analytical and experimental study of the effects of random permeability is available [1G]; it is reported that the variation in permeability must be less than 6 per cent if temperature variations are to be less than 100 F for

a particular turbine blade exposed to 2500 F. This problem may be somewhat alleviated by local transpiration cooling by introducing sufficient coolant at an upstream position; this coolant then flows over the solid downstream wall providing protection for some distance. The effect of such upstream transpiration cooling on the heat transfer and skin friction on a laminar flat-plate boundary layer has been determined by the integral method [8G].

Film cooling using discrete slots also avoids some of the difficulties encountered in completely porous surfaces. Liquid film cooling is discussed in two papers [11G, 13G], which treat the stability and attachment of the liquid film. The liquid flow did not separate if the injection angle was less than 15 deg from the tangential direction [11G].

Change of Phase

Boiling. Reference 4 of Table I presents a collection of papers on heat transfer with change of phase, covering such subjects as the mechanism of boiling, pressure drop during forced-circulation boiling, prediction of burnout, condensation of liquid metals, and a number of related topics. A theoretical analysis, which emphasizes the wave motion involved in boiling and free-convection heat-transfer processes, offers promise in predicting boiling performance [3H]. A Russian paper reports experimentally determined heat fluxes for water flowing through annular spaces of several different sizes [4H]. Heat transfer was accomplished by using the inner tube of the annulus as a resistance element. Data were reported for pressures of 6 and 20 atm over a range of inlet temperatures, and for several wall roughness values.

Another study dealing with boiling of liquid hydrogen and nitrogen in narrow annular gaps with the outer wall heated has been conducted in an effort to predict maximum safe operating temperatures for electromagnets cooled by boiling of such liquids [18H].

Appreciable effects on the boiling performance were found when small amounts of anionic, cationic, and nonionic agents were added to methanol, although no change in the surface tension was caused by the additives [10H]. Photographic studies of methanol boiling outside a horizontal copper tube revealed that the product of bubble size and frequency was constant up to a heat flux equal to 80 per cent of burnout heat flux; it increased at higher heat fluxes, finally reaching a constant value again in film boiling [12H]. An investigation of transient pool boiling, in which a heated ribbon submerged in water was subjected to large power surges, indicated that at the initiation of the process the heat transfer to the water is primarily by conduction [5H]. At very high heat fluxes when film boiling was expected, the ribbon temperature could be calculated by assuming the ribbon to be insulated.

Heat-transfer coefficients for evaporating refrigerants have been determined experimentally for trichloromonofluoromethane flowing in heated horizontal tubes [1H], and similar experiments on other refrigerants are critically reviewed by Hofmann [7H]. A simple equation is reported for predicting boiling points of a large number of organic compounds; the predictions are in satisfactory agreement with values reported for 600 compounds [11H].

Condensation. An extension of the Nusselt theory for predicting heat transfer in laminar film condensation includes the effect of the mass being added at the outer edge of the laminar film [16H]. The effect of the vapor shearing stress on laminar and turbulent film condensation has been determined by use of the momentum analogy [17H]. A related experimental program determined heat-transfer coefficients for condensing organic vapors of pure components and binary mixtures [13H].

In a theoretical and experimental program dealing with dropwise condensation [6H] the influence of the height of the cooling wall was determined, as well as the average heat transfer for adhering and downward rolling drops.

Two-phase flow. The flow patterns and heat-transfer characteristics of falling films of water and glycol-water mixtures using a vertical tube were studied [2H]. The two-phase pressure drops in pipes of 4-in and 6-in diam were measured and found to be in good agreement with the Chenoweth-Martin correlation [14H]. The two-phase flow of hydrogen in horizontal tubes was analyzed under a number of simplifying assumptions including the applicability of the Martinelli-Lockhart correlation for predicting two-phase pressure drop [15H].

The critical flow of a stream-water mixture was experimentally determined for several different pipe sizes over a range of pressures and qualities [8H]. Void fractions and pressure drops are reported for a two-phase steam-water mixture flowing through a vertical tube [9H].

Radiation

In radiation measurements, the type of radiation emanating from the black body used as the experimental standard presents a problem. If certain approximate rules are followed in its construction, the resulting radiation is generally assumed to be satisfactory for calibration purposes. A study has been reported [16J] in which the effective emissivity of a cylindrical cavity is related to the emissivity of the construction material, the ratio of the length to the radius of the cylinder, and the distance between cylinder and receiver. The analysis checked with experiments, and should prove a useful tool in future designs of black-body cavities.

For the radiation properties of rough surfaces, an analytical and experimental program [9J] reports the effect of regular protuberances on the reflective properties of a surface. Another paper [11J] shows that particle

sizes of one micron can be determined with good accuracy by measuring the change of reflectivity which occurs when a smooth surface is covered by a layer of the particles.

Among theoretical studies, the case of radiative transfer through a transparent medium in which the absorbtivity and reflectivity are nonuniform is discussed in [5J]. The problem of radiation between two infinite parallel plates is analyzed [6J]. Avoiding the conventional assumption that both surfaces are gray, actual spectral information was included in the calculation. Results show that for technically realistic problems, the gray assumption can lead to errors in the calculated net heat flux as high as 30 per cent. Stability of a fluid between two horizontal parallel plates and heated from below has been investigated [7J], including the additional complication of a radiation absorbing gas. The emission of thermal radiation by transparent materials has been studied [4J]. Basic equations are discussed, and a comparison is made with the more familiar radiation by opaque surfaces.

Experimental spectral reflectivities of liquid mercury, gallium, tellurium, indium, and their alloys are reported [12J, 13J], and compared with calculated values based on a physical model. One interesting, and discouraging result is that a theoretical model which appears valid for the individual metals is apparently invalid for an alloy of the same metals. Total normal emissivities are reported [2J] for snow, ice, and frozen ground. Experimental apparatus and measurement technique are described.

In radiation instrumentation, an ingenious radiometry scheme was reported [3J] in which change in resistance due to temperature increase of a radiation receiving coil is measured. Current is then run through the coil until a similar resistance change is obtained. This current is then a measure of the original radiation, making the method an absolute one. In the construction and calibration of two portable thermistor radiometers suitable for micrometeorological studies [17J], one instrument measures hemispherical short-wave radiation and the other total hemispherical radiation. An instrument that measures instantaneous and time-integrated solar radiation, both total and in five wave-length bands, was reported [15J]. The instrument is fully automatic and has a threshold of 10^{-5} w/cm^2. A sensitive infrared bolometer was described [1J] with a sensitivity of 1.5 v/w, a minimum detectable energy of 3.6×10^{-10} w, and a time constant of 7 millisec. Rather than use an integrating sphere for measuring diffuse reflectivity, an alternate procedure has been described [14J] using diffuse light on the sample, furnishing an independent check on conventional measurement methods.

To evaluate analytically the heat transfer in a furnace, an interesting paper [8J] illustrates the areas where our knowledge is far from complete. Information is lacking on flame temperatures, flame shapes and emission characteristics, and high-temperature radiation properties of furnace wall materials. Excellent research is being sponsored by the International Flame Radiation Committee at IJmuiden, Holland.

In gaseous radiation, a paper [10J] reported on the calculation of the absolute emissivity of high-temperature air in the temperature range 4000–9000 K. Another study [18J] analyzes the emission characteristics of a turbulent flame composed of wrinkled laminar flames.

Liquid Metals

The extensive review of liquid-metal heat transfer by Lubarsky and Kaufman is now available as a report from the National Advisory Committee for Aeronautics [7K]. Two experimental programs, dealing with the turbulent flow of alkali metals through copper tubes, yield results in good agreement with the Lubarsky-Kaufman equation [6K, 8K]. However, the experimental heat-transfer coefficients of Brown and others [2K] are somewhat higher than this prediction. In addition to the coefficients, Brown and his co-workers measured velocity and temperature distributions, from which they calculated values of the eddy diffusivities for momentum and heat transfer.

The forced-convection heat-transfer performance of lead-bismuth eutectic flowing through annular spaces, with heat supplied through the outer tube wall and with the inner wall insulated, showed results 20 per cent below the momentum-analogy predictions [9K]. An approximate method for estimating the Nusselt values, for turbulent liquid-metal heat transfer inside noncircular ducts, including rectangular, triangular, and annular geometries, and covering a number of boundary conditions, is available [4K]. Reasonable agreement of this prediction with the experimental data [9K] is reported.

Heat transfer to mercury flowing outside of staggered tube banks has been measured, and it is stated that the rates of heat transfer are greater if the tubes are wetted by the mercury [5K].

An experimental program is reported wherein 24 rotating hollow cylindrical elements partly filled with mercury were subjected to speeds of 500, 1000, and 1500 rpm while heat was transferred to the outer region of the element, and heat was removed at the base [1K].

Limited data for boiling [3K] and condensation (Table 1, item 4) of liquid metals are reported. The condensation results were found to be substantially lower than predictions from theoretical considerations, and no explanation could be advanced.

Measurement Techniques

There is continuing effort to obtain more accurate and extensive data on thermal conductivity. The development of a transient technique [13L] has allowed a rapid determination of the thermal conductivity of solids and liquids during a time interval of 0.1 sec, making it possible to study the thermal-conductivity change in a solution while a chemical reaction is taking place. A simple bridge method for determination of the

thermal conductivity of gases or gaseous mixtures is discussed [19L], and possible experimental errors are evaluated.

A new approach to the determination of thermal conductivities of gases is presented [5L]. Rather than measure the thermal conductivity directly, the Prandtl number of the gas is determined by measuring the recovery temperature on a cylindrical wire in high-speed laminar longitudinal flow. The thermal conductivity is then calculated, using more easily determined values of viscosity and specific heat. A rapid steady-state method is reported in [1L] wherein the thermal conductivity of solids can be determined every 20 min. When applied to measurements of rocks, the data were reproducible within 0.4 per cent. Another transient technique for finding thermal conductivities of metals [14L, 15L], particularly suitable when the temperature level is high, gives a measurement in 30 sec with an estimated uncertainty of ±2 per cent. A thermal-conductivity cell using transistors is reported [26L]. Designed for the measurement of gas concentrations, the use of transistors produces a substantial sensitivity increase over conventional means. The authors state that previous claims of instability in transistors are unwarranted.

The use of a calibrated electrical-conductivity cell to measure turbulent fluctuations is discussed [23L]. This experimental technique can measure the scale of turbulence within a standard deviation of 2.8 per cent.

Although electric analogs for the solution of heat-transfer problems represent established technique, new and ingenious applications appear. To gather together this scattered and useful literature, a survey paper [12L] was presented, the second of a three-paper series. It deals primarily with discrete systems such as direct-current resistance networks. Another study [22L] reports on a simple method of changing the mesh size in a resistance network so that certain areas of the field can be studied more closely. A careful study of design problems and errors in electrolytic tanks is reported [16L]. Results of control experiments indicate that accuracy is high in level-tank work: but is seldom better than 3 per cent in tilted-tank studies.

Temperature probes, especially for use in high-velocity, high-temperature gas streams, have been further studied; in particular, pneumatic-type probes. The effects of thermal relaxation and specific heat changes on the simple probe theory have been studied [18L]. References [25L] and [10L] describe particular designs utilizing chromel-alumel [25L] and platinum-platinum rhodium thermocouple elements [10L]. Both papers present the results of experimental measurements and comparisons with other temperature-measuring techniques. Such probes have been successfully used in gas streams at temperatures as high as 4000 deg R. A combination pneumatic thermometer and hygrometer is reported in [4L] which is capable of measuring the temperature and moisture parameters in a hot gas stream at a temperature level of 2000 F. A miniature thermistor probe for use at temperatures of 150 F is described [2L]. The probe diameter is 0.8 mm and the temperature sensitivity is 50 ohms per deg Celcius.

More laboratories are setting up equipment for precise temperature calibrations. A report on resistance thermometry [20L] discusses the timewise stability of the Mueller Bridge, the effect of cold working and heat treating the platinum element, and the stability of triple-point cells. The use of precision mercury thermometers is analyzed [21L]. To reduce errors which occur when glass is used as the envelope, mercury-in-quartz thermometers are presented as a possibility. A precise and automatic manometer reader is described [8L].

A flow-visualization technique which can be used in low-density flows is discussed [24L]. By utilizing oxygen absorption in the ultraviolet, photographs can be taken of shock waves formed by bodies in the gas stream. A general investigation of various interferometry methods for flow visualization in wind tunnels is presented [3L], with criteria for determining the best method of observing the over-all flow pattern or of making a detailed analysis of a small region.

As a shock wave passes through an arc discharge, an increase in brightness is apparent in the shock region. Utilizing this phenomenon, a method was developed [6L] to measure the arc temperatures taking into account variations in specific heat and molecular weight. New techniques in hypersonic heat-transfer measurements have been reported. By placing a shroud around the wind tunnel model to simulate the pressure field in hypersonic flow, larger model sizes and Reynolds numbers are obtainable [9L]. A heat meter for local surface heat-rate measurements was discussed in [11L], the meter being the size of a pinhead. To reproduce conditions likely to be met during high-speed flight, a kinetic heating simulation system was developed [7L].

And finally, a boon to heat-transfer investigators who must work with the fact that heat flow is proportional to the distance derivative of temperature: A device, elegant in its simplicity, for the accurate determination of tangents of curves [17L].

Heat Transfer Applications

Heat exchangers. The AIChE published a recommended standard testing procedure for heat exchangers [2M]. Intended for designers and users of shell-and-tube heat exchangers, the guide is particularly valuable for smaller companies which have insufficient resources to evolve their own testing procedures.

A general discussion of heat-transfer media for high-temperature heat exchange [8M] directs attention to available fluids which are suitable for reactors and gas turbines. In line with the continuing interest in "compact" heat exchangers, the mean temperature differences in one, two, and three-pass cross-flow heat exchangers are discussed [9M]. It reviews all known solutions, and numerical solutions are given for previously unsolved cases. Equations are presented in [5M] for the mean temperature difference, and feedwater and condensate outlet temperatures, in a feedwater heater. Work continues on the prediction of over-all shell-and-tube heat-

exchanger performance from basic heat-transfer data [6M]. By dividing the exchanger into separate flow zones, a prediction was achieved which agrees satisfactorily with experiment. The effect of seal leakage in a rotary regenerator—in particular the effect on over-all cycle performance—was analyzed [7M]. A procedure [3M] allows, by means of charts, a rapid determination of the core dimensions in a cross-flow heat exchanger when the operating parameters are prescribed.

The problem that continues to haunt the designers and users of heat-exchange equipment is whether the configuration selected is optimum with respect to size, volume, weight, etc. Two papers, [1M] and [4M] consider this aspect, especially with regard to gas-turbine and reactor applications.

Aircraft and missiles. Various aspects of heat transfer connected with high-velocity flight and especially with the re-entry problem of missiles and satellites have been investigated. Von Karman discussed the problems connected with aerodynamic heating [10P]. Dorrance dealt with the heating effect in the continuum-flow regime [1P]. Methods available for cooling of the blades of gas turbines, such as internal-convection cooling, spray cooling, film, transpiration, and natural-convection cooling, have been compared [3P].

Heat transfer in the various components of a rocket, including the thrust chamber and nozzle, is presented in [8P]. The results of transient heating on simple structures has been studied by the use of powerful radiation heaters [2P]. More and more attention is directed toward effective cooling of electronic equipment [5P]. A group of papers [4P, 6P, 7P] discusses the calculation of the temperature history of lubricant as it passes through the film of a bearing, for the condition of adiabatic walls as well as cooled walls.

In view of recent development in astronautics, the heat-transfer problem faced by the human body when subjected to extremes of temperature is of vital interest [9P, 11P, 12P]. The safe exposure time for a normal man at rest was reported by Konrad Buettner [12P].

Thermal stress and shock. New solutions for steady-state thermal stress in various geometries were reported. Experiments and theoretical studies were made to determine the influence of thermal stress on the reduction of torsional and flexural stiffness of structures. Buckling and warping due to thermal stresses received attention.

Goodier [7Q] gives a concise presentation of known steady-state thermal-stress solutions for a large number of special cases; this should be of value to designers. Steady-state thermal stresses were determined for a hollow sphere [11Q], an infinite solid disk [16Q], an infinite disk with a single central hole [13Q], an infinite disk with two circular holes [21Q], and a semi-infinite medium bounded by a plane [19Q]. Unsteady thermal stresses in hollow spheres were also investigated [20Q]. Composite geometries as encountered in clad fuel plates of nuclear reactors received attention [18Q, 24Q]. Temperature and thermal-stress distributions were calculated for transpiration-cooled structures. An approximate analysis for determining thermal stresses in a thin plate of variable thickness is available, and working examples are presented [12Q].

Thermal stresses in bent tubes with rigidly supported ends are discussed [4Q] and fatigue data for piping subjected to thermal cycling are presented [3Q]. Temperature and thermal stress distributions encountered in aircraft structures have been analyzed [6Q, 9Q, 10Q, 15Q]. A dimensional analysis is performed to determine the proper parameters for scaling such aircraft models in the study of thermal stresses [14Q]. The thermal contact resistance between the skin and the web in these aircraft structures has a significant influence on the thermal stresses [1Q, 2Q, 5Q].

The Rayleigh-Ritz method was used to analyze torsional vibrations of a long thin solid wing subjected to aerodynamic heating [17Q]. Vibration frequencies of simple wing structures subjected to transient heating were experimentally determined [22Q], and the measured reduction in frequency was much smaller than predicted by the analysis of Budiansky and Mayer. Buckling of aircraft structures due to thermal stresses is discussed [8Q, 23Q], and criteria for predicting it are presented.

References

Conduction

1A Churchill, S. W., others, Ind. Eng. Chem. 49, 1007 (1957).
2A Cooper, M., Mayo, E. E., J. Aeronaut. Sci. 24, 461 (1957).
3A Crank, J., Quart. J. Mech. Appl. Math. 10, 220 (1957).
4A deVries, D. A., J. Meteorology 14, 71 (1957).
5A Elrod, H. G., Jr., Trans. ASME 79, 1519 (1957).
6A Fieber, H., Selig, F., Oesterreichisches Ing.-Archiv 10, 96 (1957).
7A Gillis, J., J. Phys. Soc. (Japan) 11, 993 (1956).
8A Goldenberg, H., Proc. Phys. Soc. 69, 256 (1956).
9A Goodman, T. R., Proc. 1957 Heat Transfer and Fluid Mechanics Inst., Stanford Univ. Press. p. 383 (1957).
10A Hurwicz, H., Tischer, R. G., Mech. Eng. 79, 922 (1957).
11A Kogan, M. G., Sov. Phys.-Tech. Phys. 1155 (1957).
12A Mascarenhas, S., Nuovo Cimento 5, 1118 (1957).
13A Masters, J. I., Stein, S., Rev. Sci. Instr. 27, 1056 (1956).
14A Newman, P. C., Brit. J. Appl. Phys. 8, 162 (1957).
15A Pipes, L. A., J. Franklin Inst. 263, 195 (1957).
16A Ritchie, R. H., Sakakura, A. Y., J. Appl. Phys. 27, 1453 (1956).
17A Schneider, P. J., Jet Propulsion 27, 883 (1957).
18A Schuh, H., VDI-Forschungsheft 23, 42 (1957).
19A Selig, F., Fieber, H., Oesterreichisches Ing.-Archiv 11, 37 (1957).
20A Vodicka, V., Z. angew. Math. u. Phys. 8, 53 (1957).
21A White, G. W. T., Appl. Sci. Research 6, 433 (1957).

Channel Flow

1B Bialokoz, J. E., Saunders, O. A., Combustion and Boilerhouse Eng. 10, 412 (1956).
2B Bringer, R. P., Smith, J. M., A.I.Ch.E. Journal 3, 49 (1957).
3B Farbar, L., Morley, M. J., Ind. Eng. Chem. 49, 1143 (1957).
4B Gee, R. E., Lyon, J. B., ibid., p. 956 (1957).
5B Glaser, H., Chem.-Ing.-Tech. 29, 176 (1957).
6B Grigull, U., ibid., 28, 551 (1956).
7B Gross, J. F., Van Ness, H. C., A.I.Ch.E. Journal 3, 172 (1957).
8B Hallman, T. M., Trans. ASME 78, 1831 (1956).
9B Hansen, A. G., J. Aeronaut. Sci. 24, 217 (1957).
10B Hughes, W. F., Osterle, J. F., Trans. ASME 79, 1313 (1957).
11B Hunziker, R. R., Florio, J. S., J. Aeronaut. Sci. 24, 782 (1957).
12B Laird, W. M., Ind. Eng. Chem. 49, 138 (1957).
13B Levy, S., Trans. ASME 78, 1627 (1957).
14B Marris, A. W., Canadian J. Phys. 35, 410 (1957).
15B Metzner, A. B., others, A.I.Ch.E. Journal 3, 92 (1957).
16B Morgan, A. J. A., J. Aeronaut. Sci. 24, 315 (1957).
17B Patten, T. D., Chart. Mech. Eng. 4, 290 (1957).
18B O'Sullivan, J. K., Eng. 183, 684 (1957).
19B Powell, W. B., Jet Propulsion 27, 776 (1957).
20B Rea, S. E., Ablow, C. M., Trans. ASME 79, 789 (1957).
21B Ruth, B. F., Lang, H. H., A.I.Ch.E. Journal 3, 117 (1957).
22B Shiva, N. S., Chem. Eng. Sci. 6, 283 (1957).

HEAT TRANSFER

23B Sleicher, C. A., Jr., Tribus, M., Trans. ASME 79, 789 (1957).
24B Smith, J. W., Epstein, N., A.I.Ch.E. Journal 3, 242 (1957).
25B Wolf, H., Lehman, J. H., Jet Propulsion 27, 897 (1957).
26B Yih, C. S., Sangster, W. M., Philos. Mag. 2, 305 (1957).

Boundary Layers

1C Acrivos, A., Chambré, P. L., Ind. Eng. Chem. 49, 1025 (1957)
2C Bartz, D. R., Jet Propulsion 27, 49 (1957).
3C Chambré, P. L., Appl. Sci. Research 6, 393 (1957).
4C Christian, W. J., Kezios, S. P., Proc. 1957 Heat Transfer and Fluid Mechanics Inst., Stanford Univ. Press, Palo Alto, Calif., p. 359.
5C Cohen, C. B., Reshotko, E., ibid., 1293 (1956).
6C Cohen, C. B., Reshotko, E., Natl. Advisory Comm. Aeronaut., Rept. No. 1294 (1956).
7C Davies, D. R., Bourne, D. E., Quart. J. Mech. and Appl. Math. 9, 457 (1957)
8C Diaconis, N. S., others, NACA Tech. Note 3928 (1957).
9C Dooley, D. A., Proc. 1957 Heat Transfer and Fluid Mechanics Inst., Stanford Univ. Press. Palo Alto, Calif., p. 321.
10C Eckert, E. R. G., others, J. Aeronaut. Sci. 24, 549 (1957).
11C Ellison, T. H., J. Fluid Mechanics 2, 456 (1957).
12C Fay, J. A., others, Jet Propulsion 27, 672 (1957).
13C Hains, F. D., J. Aeronaut. Sci. 24, 623 (1957).
14C Hool, J. N., Aeronaut. Res. Council Repts. and Mem. (Gt. Brit.) 2986 (1957).
15C Hottel, H. C., others, Jet Propulsion 27, 28 (1957).
16C Hsu, N. T., Sage, B. H., A.I.Ch.E. Journal 3, 405 (1957).
17C Johnson, D. S., J. Appl. Mechanics 24, Trans. ASME 79, 2 (1957).
18C Korobkin, I., Gruenewald, K. H., J. Aeronaut. Sci. 24, 188 (1957).
19C Kuo, Y. H., ibid., p. 345 (1957).
20C Lewis, J. P., Ruggeri, R. S.,Natl. Advisory Comm. Aeronaut., Tech. Note 3837 (1956).
21C Lighthill, M. J., J. Fluid Mechanics 2, 1 (1957).
22C Maslen, S. H., Ostrach, S., Quart. Appl. Math. 15, 98 (1957).
23C Morduchow, M., others, Natl. Advisory Comm. Aeronaut., Tech. Note 4037 (1957).
24C Pai, S. I., J. Aeronaut. Sci. 23, 1012 (1956).
25C Romig, M. F., Jet Propulsion 26, 1098 (1956).
26C Seban, R. A., Trans. ASME 79, 1545 (1957).
27C Sparrow, E. M., Gregg, J. L., J. Aeronaut. Sci. 24, 852 (1957).
28C Sparrow, E. M., Gregg, J. L., ibid., p. 776 (1957).
29C Szablewski, W., Ing.-Archiv. 25, 10 (1951).
30C Townsend, A. A., J. Fluid Mechanics 1, 561 (1956).
31C Wood, W. W., Kirkwood, J. G., J. Appl. Phys. 28, 395 (1957).

Flow With Separated Regions

1D Calderbank, P. H., Pogorski, L. A., Trans. Inst. Chem. Engrs. 35, 195 (1957).
2D Douglas, W. J. M., Churchill, S. W., Chem. Eng. Prog. 53, 226 (1957).
3D Glawe, G. E., Johnson, R. C., Natl. Advisory Comm. Aeronaut., Tech. Note 3934 (1957).
4D Hoe, R. J., Dropkin, D., others, Trans. ASME 79, 899 (1957).
5D Jacob, A., Osberg, G. L., Canadian J. of Chem. Eng. 35, 5 (1957).
6D Kestin, J., Maeder, P. F., Natl. Advisory Comm. Aeronaut., Tech., Note 4018 (1957).
7D Kwong, S. S., Smith, J. M., Ind. Eng. Chem. 49, 894 (1957).
8D Laufer, J., McClellan, R., J. Fluid Mechanics 1, 276 (1956).
9D Tong, L. S., London, A. L., Trans. ASME 79, 1558 (1957).
10D Yagi, S., Kunii, D., A.I.Ch.E. Journal 3, 373 (1957).

Transfer Mechanism

1E Bosnjakovic, F., Chem.-Ing.-Tech. 29, 187 (1957).
2E Cole, G. H. A., Advances in Phys. 5, 452 (1956).
3E Devienne, F. M., J. Aeronaut. Sci. 24, 403 (1957).
4E Dillon, P. L. P., Line, L. E., Jr., Jet Propulsion 26, 1091 (1956).
5E Domm, U., DVL Bericht, 15 (1956).
6E Gadd, G. E., J. Fluid Mechanics 2, 105 (1957).
7E Hartnett, J. P., Eckert, E. R. G., Trans. ASME 79, 751 (1957).
8E Hsu, N. T., Kazuhiko, S., Ind. Eng. Chem. 48, 2218 (1956).
9E Pengelley, C. D., J. Appl. Phys. 28, 86 (1957).
10E Reichardt, H., Natl. Advisory Comm. Aeronaut., Tech. Note 1408 (1957).
11E Reid, W. H., Appl. Sci. Research 6A, 85 (1956).
12E Scheller, W. A., Brown, G. M., Ind. Eng. Chem. 49, 1013 (1957).
13E Talbot, L., J. Aeronaut. Sci. 24, 458 (1957).

Natural Convection

1F Bevans, J. T., Ind. Eng. Chem. 49, 114 (1957).
2F Chandrasekhar, S., Proc. Roy. Soc. (London) A237, 476 (1956).
3F Chandrasekhar, S., Philosophical Magazine 2, 845 (1957).
4F Doughty, D. L., Drake, R. M., Jr., Trans. ASME 78, 1843 (1956).
5F Farber, E. A., Rennat, H. O., Ind. Eng. Chem. 49, 437 (1957).
6F Goody, R. M., J. Fluid Mechanics 1, 424 (1956).
7F Hartnett, J. P., Welsh, W. E., Trans. ASME 79, 1185 (1957).
8F Kuo, H. L., J. Meteorology 13, 521 (1956).
9F Mahony, J. J., Proc. Roy. Soc. (London) A240, 412 (1957).
10F Mathers, W. G., others, Ind. Eng. Chem. 49, 961 (1957).
11F Nakagawa, Y., Proc. Roy. Soc. (London) A240, 108 (1957).
12F Ostrach, S., Trans. ASME 79, 299 (1957).
13F Schmidt, E., Chem.-Ing.-Tech. 28, 175 (1956).
14F Sherwood, T. K., Cooke, N. E., A.I.Ch.E. Journal 3, 37 (1957).
15F Siegel, R., Norris, R. H., Trans. ASME 79, 663 (1957).
16F Sparrow, E. M., Gregg, J. L., ibid. 78, 1823 (1956).
17F Stewartson, K., Jones, L. T., J. Aeronaut. Sci. 24, 379 (1957).
18F Thomas, D. B., Townsend, A. A., J. Fluid Mechanics 2, 473 (1956).
19F Wooding, R. A., ibid., p. 273 (1957).

Transpiration and Mass-Transfer Cooling

1G Esgar, J. B., Richards, H. T., Natl. Advisory Comm. Aeronaut., Research Mem. E53G16 (1953).
2G Friedlander, S. K., A.I.Ch.E. Journal 3, 43 (1957).
3G Hartnett, J. P., Eckert, E. R. G., Trans. ASME 79, 247 (1957).
4G Hasimoto, H., J. Phys. Soc. Japan 12, 68 (1957).
5G Maxwell, R. W., Storrow, J. A., Chem. Eng. Sci. 6, 204 (1957).
6G Ness, N., J. Aeronaut. Sci. 24, 626 (1957).
7G Potter, O. E., Chem. Eng. Sci. 6, 170 (1957).
8G Rubesin, M. W., Inouye, M., Natl. Advisory Comm. Aeronaut. Tech. Note 3969 (1957).
9G Rubesin, M. W., others, Natl. Advisory Comm. Aeronaut., Res. Mem. A55I19 (1957).
10G Scala, S. M., Sutton, G. W., Jet Propulsion 27, 895 (1957).
11G Warner, C. F., Reese, B. A., Jet Propulsion 27, 877 (1957).
12G Yasuhara, M., J. Phys. Soc. Japan 12, 177 (1957).
13G Zucrow, M. J., Graham, A. R., Jet Propulsion 27, 650 (1957).

Change of Phase

1H Baker, M., Miller, J. T., Refrig. Eng. 65, 43 (1957).
2H Brauer, H., VDI-Forschung. No. 457 (1956).
3H Chang, Y. P., Trans. ASME 79, 1501 (1957).
4H Chirkin, Y. S., Jukin, V. P., Soviet Phys. 1503 (1957).
5H Cole, R., Natl. Advisory Comm. Aeronaut., Tech. Note 3885 (1956).
6H Gregorig, R., Chem.-Ing.-Tech. 28, 551 (1956).
7H Hofmann, E., Kaltetechnik 9, 7 (1957).
8H Isbin, H. S., others, A.I.Ch.E. Journal 3, 361 (1957).
9H Isbin H. S., others, ibid., p. 136 (1957).
10H Lowery, A. J., Jr., Westwater, J. W., Ind. Eng. Chem. 49, 1445 (1957).
11H Ogata, Y., Tsuchida, M., ibid., p. 415 (1957).
12H Perkins, A. S., Westwater, J. W., A.I.Ch.E. Journal 2, 471 (1956).
13H Pressburg, B. S., Todd, J. B., ibid. 3, 348 (1957).
14H Reid, R. C., others, ibid., p. 321 (1957).
15H Rogers, J. D., ibid. 2, 536 (1956).
16H Rohsenow, W. M., Trans. ASME 78, 1645 (1956).
17H Rohsenow, W. M., ibid., p. 1637 (1956).
18H Sydoriak, S. G., Robert, T. R., J. Appl. Phys. 28, 143 (1957).

Radiation

1J Archbold, E., J. Sci. Instr. 34, 240 (1957).
2J Dunkle, R. V., others, Refrig. Eng. 65, 33 (1957).
3J Eppley, M., Karoli, A. R., J. Opt. Soc. Amer. 47, 748 (1957).
4J Gardon, R., J. Am. Cer. Soc. 39, 278 (1956).
5J Giovanelli, R. G., Australian J. Phys. 10, 227 (1957).
6J Goodman, S., U. S. Bur. Standards—J. Research 58, 37 (1957).
7J Goody, R. M., J. Fluid Mechanics 1, 424 (1956).
8J Greyson, M., Mazie, G. P., others, Trans. ASME 78, 1741 (1956).
9J Hasunama, H., Nara, J., J. Phys. Soc. Japan 12, 1117 (1957).
10J Keck, J., others, Proc. 1957 Heat Transfer Fluid Mechanics Inst., Stanford Univ. Press, Palo Alto, Calif. p. 279.
11J Rose, H. E., J. Appl. Chem. 7, 244 (1957).
12J Schulz, L. G., J. Opt. Soc. Amer. 47, 70 (1957).
13J Schulz, L. G., ibid., p. 64 (1957).

14J Shibata, K., ibid., p. 172 (1957).
15J Sihvonen, Y. T., Rev. Sci. Instr. 28, 628 (1957).
16J Vollmer, J., J. Opt. Soc. Amer. 47, 926 (1957).
17J Ward, W. H., J. Sci. Instr. (London) 34, 317 (1957).
18J Williams, F., Fuhs, A. E., Jet Propulsion 27, 1099 (1957).

Liquid Metals

1K Bayley, F. J., Bell, N., Eng. 183, 300 (1957).
2K Brown, H. E., others, Trans. ASME 79, 279 (1957).
3K Camack, W. G., Forster, H. K., Jet Propulsion 27, 1104 (1957).
4K Hartnett, J. P., Irvine, T. F., Jr., A.I.Ch.E. Journal 3, 313 (1957).
5K Hoe, R. J., others, Trans. ASME 79, 899 (1957).
6K Kuczen, K. D., Bump, T. R., Nuclear Sci. Eng. 2, 181 (1957).
7K Lubarsky, B., Kaufman, S. J., Natl. Advisory Comm. Aeronaut. Rept. No. 1270 (1956).
8K Novikov, I. I., others, J. Nuclear Energy 4, 387 (1957).
9K Seban, R. A., Casey, D. F., Trans. ASME 79, 1514 (1957).

Measurement Techniques

1L Beck, A., J. Sci. Instr. 34, 186 (1957).
2L Belfield, W., Johnson, R. W., ibid., p. 209 (1957).
3L Chevalerias, R., others, J. Opt. Soc. Amer. 47, 703 (1957).
4L Coldren, C. L., Comings, E. W., Chem. Eng. Prog. 53, 403 (1957).
5L Eckert, E. R. G., Irvine, T. F., Jr., J. Appl. Mechanics 24, Trans. ASME 79, 25 (1957).
6L Edels, H., Whittaker, D., Proc. Roy. Soc. (London) A240, 54 (1957).
7L Simulating Kinetic Heating in High-Speed Aircraft, Engng. 184, 111 (1957).
8L Farquharson, J., Kermicle, H. A., Rev. Sci. Instr. 28, 324 (1957).
9L Ferri, A., Libby, P. A., J. Aeronaut. Sci. 24, 464 (1957).
10L Glawe, G. E., Jet Propulsion 27, 543 (1957).
11L Hartwig, F. W., Bartsch, C. A., others, J. Aeronaut. Sci. 24, 238 (1957).
12L Higgins, T. J., Appl. Mechanics Rev. 10, 49 (1957).
13L Hill, R. A. W., Proc. Roy. Soc. (London) A239, 476 (1957).
14L Hsu, S. T., Rev. Sci. Instr. 28, 333 (1957).
15L Hsu, S. T., Trans. ASME 79, 1197 (1957).
16L Kennedy, P. A., Kent, G., Rev. Sci. Instr. 27, 916 (1956).
17L King, A. R., J. Sci. Instr. 33, 506 (1956).
18L Kuhns, P. W., Natl. Advisory Comm. Aeronaut., Tech. Note 4026 (1957).
19L Madan, M. P., J. Franklin Inst. 263, 207 (1957).
20L McLaren, E. H., Canadian J. of Phys. 35, 78 (1957).
21L Moreau, H., others, J. Sci. Instr. 34, 147 (1957).
22L Palmer, P. J., Redshaw, S. C., ibid., p. 407 (1957).
23L Prausnitz, J. M., Wilhelm, R. H., Rev. Sci. Instr. 27, 941 (1956).
24L Sherman, P. M., J. Aeronaut. Sci. 24, 93 (1957).
25L Simmons, F. S., Glawe, G. E., Natl. Advisory Comm. Aeronaut., Tech. Note 3893 (1957).
26L Walker, R. E., Wastenberg, A. A., Rev., Sci. Instr. 28, 789 (1957).

Heat Exchangers

1M Behmer, R. E., Hoffman, B. L., Nuclear Sci. and Eng. 2, 14 (1957).
2M Guide to Heat Exchanger Testing, Chem. Eng. Prog. 53, 130 (1957).
3M Diaguila, A. J., Livingood, J. N. B., Natl. Advisory Comm. Aeronaut., Tech. Note 3891 (1956).
4M Fax, D. H., Mills, R. R., Jr., Trans. ASME 79, 653 (1957).
5M Gardner, K. A., ibid., p. 1494 (1957).
6M Gupta, R. K., Katz, D. L., Ind. Eng. Chem. 49, 998 (1957).
7M Harper, D. B., Trans. ASME 79, 233 (1957).
8M Rottenburg, P. A., Trans. Inst. Chem. Engrs. 35, 21 (1957).
9M Stevens, R. A., Fernandez, J., others, Trans. ASME 79, 287 (1957).

Aircraft and Missiles

1P Dorrance, W. H., Aeronaut. Eng. Rev. 16, 26 (1957).
2P Duberg, J. E., Trans. ASME 79, 1014 (1957).
3P Esgar, J. B., others, ibid., p. 645 (1957).
4P Hughes, W. F., Osterle, J. F., ibid., p. 1225 (1957).
5P Kaye, J., Proc. Inst. Radio Engrs. 44, 977 (1956).
6P Pinkus, O., Sternlicht, B., Trans. ASME 79, 337 (1957).
7P Purvis, M. B., others, ibid., p. 343 (1957).
8P Sutton, G. P., J. Brit. Interplanet. 15, 192 (1956).
9P Taylor, C. L., Trans. ASME 79, 1024 (1957).
10P von Karman, T., Flugwelt, p. 163 (1957).
11P Ward, J. E., J. Av. Medicine, 27, 429 (1956).
12P Woodcock, A. H., others, Mech. Eng. 79, 1029 (1957).

Thermal Stress and Shock

1Q Barzelay, M. E., Holloway, G. F., Natl. Advisory Comm. Aeronaut., Tech. Note 3824 (1957).
2Q Brooks, W. A., Jr., others, ibid. 4052 (1957).
3Q Coffin, L. F., Jr., Trans. ASME 79, 1637 (1957).
4Q Endres, W., Forsch. Gebiete Ing. 23, 33 (1957).
5Q Gatewood, B. E., J. Aeronaut. Sci. 24, 152 (1957).
6Q Goldberg, M. A., ibid. 23, 981 (1956).
7Q Goodier, J. N., J. Appl. Mechanics 24, 467, Trans. ASME 79 (1957).
8Q Hoff, N. J., J. Aeronaut. Sci. 23, 1019 (1956).
9Q Isakson, G., ibid. 24, 611 (1957).
10Q Mar, J. W., Schmit, L. A., Trans. ASME 79, 990 (1957).
11Q McDowell, E. L., Sternberg, E., J. Appl. Mechanics 24, 376, Trans. ASME 79 (1957).
12Q Mendelson, A., Hirschberg, M., Natl. Advisory Comm. Aeronaut., Tech. Note 3778 (1956).
13Q Norbury, J. F., Aircraft Eng. 29, 132 (1957).
14Q O'Sullivan, W. J., Jr., Natl. Advisory Comm. Aeronaut., Tech. Note 4115 (1957).
15Q Przemieniecki, J. S., J. Roy. Aeronaut. Soc. 60, 799 (1956).
16Q Sharma, B., J. Appl. Mechanics 23, 527, Trans. ASME 79 (1957).
17Q Singer, J., J. Aeronaut. Sci. 24, 620 (1957).
18Q Smith, C. O., Nuclear Sci. and Eng. 2, 213 (1957).
19Q Sternberg, E., McDowell, E. L., Quart. Appl. Math. 14, 318 (1957).
20Q Trostel, R., Ing.-Archiv 24, 373 (1956).
21Q Van Der Linden, C. A. M., Appl. Sci. Research 6A, 205 (1956).
22Q Vosteen, L., others, Natl. Advisory Comm. Aeronaut., Tech. Note 4054 (1957).
23Q Zender, W., Pride, R. A., ibid. 4053 (1957).
24Q Zwick, S. A., Jet Propulsion 27, 872 (1957).

Table I Books Published During the Year

1 Baker, H. W., "Technology of Heat," Longmans, Green and Co., New York, 1956.
2 Brown, A. I., Marco, S. H., "Introduction to Heat Transfer," 3rd ed., McGraw-Hill, New York, 1958.
3 Carman, P. C., "Flow of Gases Through Porous Media," Academic Press, New York, 1956.
4 Chemical Engineering Symposium Series, v. 52, no. 18, 1956, "Heat Transfer."
5 Corcoran, W. H., Opfell, J. B., Sage, B. H., "Momentum Transfer in Fluids," Academic Press, Inc., New York, 1956.
6 Crank, J., "The Mathematics of Diffusion," Oxford University Press, London, 1956.
7 Drew, T. B., Hoopes, J. W., Jr., "Advances in Chemical Engineering," v. 1, Academic Press, New York, 1956.
8 Giedt, W. H., "Principles of Engineering Heat Transfer," D. van Nostrand Co., Princeton, 1957.
9 Grigull, U., "Warmeubertragung," Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, 1956.
10 *Houille Blanche*, v. 12, no. 1, 1957.
11 Jakob, H., Hawkins, G. A., "Elements of Heat Transfer," 3rd ed., J. Wiley and Sons, Inc., New York, 1957.
12 Jakob, M., "Heat Transfer," v. 2, J. Wiley and Sons, New York, 1957.
13 Jones, E. B., "Instrument Technology—v. I, Measurement of Pressure, Level, Flow, and Temperature. v. 2, Analysis Instruments," Butterworths Sci. Pub., London, 1953 and 1956.
14 Pai, Shih-I, "Viscous Flow Theory I. Laminar Flow," D. van Nostrand Co., Princeton, 1956.
15 Pepperhoff, W., "Temperaturstrahlung," Darmstadt, Verlag D. Steinkopff, 1956.
16 Rubin, E. S., Kerwin, E. M., Jr., Appl. Mech. 9th Internatl. Cong., Brussels, Sept. 5–13, 1956; Papers on Heat Transfer and Unsteady Aerodynamics, 1956.
17 Schack, A., "Der Industrielle Wärmeübergang: für Praxis und Studium mit grundlegenden Zahlenbeispielsen," 5th ed., Düsseldorf, Verlag Stahleisen m.b.H., 1957.
18 Scheidegger, A. E., "The Physics of Flow Through Porous Media," Macmillan, New York, 1957.
19 Séminaire D'Aérothermique de la Faculté Des Sciences de Paris, France, Min. de l'Air NT 63, 1957.
20 Southwell, R. V., "Relaxation Methods in Theoretical Physics," Oxford University Press, London, 1956.
21 1957 Heat Transfer and Fluid Mechanics Institute, Stanford University Press, Palo Alto, Calif.

PROGRESSIVE MECHANIZATION

.....Economic Justification and Measurement of Actual Results...

By A. J. Dunkle, Superintendent, Production Engineering, A. C. Spark Plug Division, General Motors Corp., Flint, Mich.

Because present-day accounting practices generally do not provide factual unit-burden cost, the economic justification of mechanization has been predicated solely on direct-labor savings. To determine the real effect mechanization has on the total-product cost, AC Spark Plug has made a special study.

Phases of Manufacture

Progressive mechanization embraces all or a combination of any six different and distinct phases of manufacture: (*a*) Manual handling, (*b*) primary mechanization of manual work, (*c*) advanced mechanization of manual work, (*d*) elimination and combination of operations, (*e*) integration of processes, (*f*) automation of processes.

Manual handling. In this stage no mechanization of any type is involved. Processing of the part and movement of material within the operation and between operations are accomplished solely through human effort.

Primary mechanization of manual work. Certain mechanical means are substituted for human effort in the processing of the part and the lifting or carrying of the part within or between operations. Simple machine tools, cranes, hoists, trucks, and the like, are the primary means of mechanization.

Advanced mechanization. In this stage of progressive mechanization, mechanical means such as conveyers or chutes begin to effect the first element of control over the processing of the part and the distribution and movement of the material.

Elimination and combination of operations. Here mechanical means begin to take over full control of the processing, distribution, and movement of the part.

Integration of processes. Integration brings together various operations, and mechanical controls to provide a continuous flow of material. Corrective adjustments are made by the operator based on trends indicated by automatic inspection.

Automation of processes. In this stage, constituting full mechanization, feedback controls are applied to the integrated processes. Adjustments are made automatically when necessary, based on the trends indicated by the inspection operation.

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., December 1–6, 1957, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 57—A-215.

Economic Evaluation

As pointed out earlier, progressive mechanization covers a broad scope of possible combinations of the six stages of manufacture. Each combination must be considered on its individual economic merits in developing the plan of operations that will give the highest return on investment.

The first step in developing the economic study involves determination of total actual unit cost of the existing method of manufacture. This includes actual burden including machine-depreciation unit cost as well as direct-labor unit cost. The importance of determining existing actual unit burden cost cannot be overemphasized.

The second step in the study is the establishment of the most economical manual method using present facilities. Assuming unit material cost to remain constant, the actual unit burden cost and the unit direct-labor cost of the best manual method should be used as base against which to compare unit cost of the various proposed plans of mechanization.

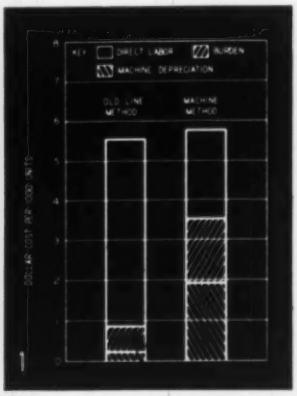
It is not uncommon for total burden cost to equate 200 per cent of direct-labor cost. Therefore it is logical and imperative to determine the impact mechanization will have on unit burden cost of the product involved. As full mechanization is approached, usually capital investment (burden depreciation) increases at a higher rate than the reduction in unit product cost. Maintenance costs also rise at a higher rate on complex specialized equipment, and if model or engineering changes are involved, the useful life of the equipment may be abbreviated to the extent that machine-depreciation cost per unit of production is prohibitive. This suffices to emphasize the importance of using return on investment as the determinant in the economic justification rather than machine pay-off years which are based on direct-labor savings only.

Per cent return on investment is the ratio of profit to the investment required to produce that profit. Since profit before taxes is the difference between total product cost and selling price, it is obvious that the return-on-investment method of determining economic justification of a new process must include the effects mechanization has on all elements of cost if the forecast return is to be in alignment with actual results.

The fallacy of using machine pay-off years developed

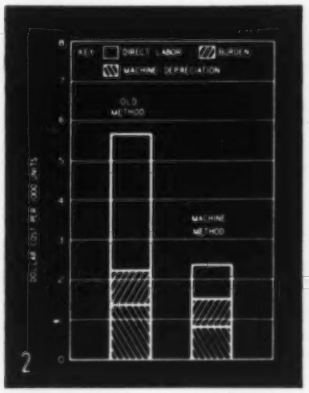
Fig. 1—Comparative costs of two methods of assembling fuel-pump valves. Elements affected only are shown. Material costs are the same.

Fig. 2—Comparative costs of two methods of fabricating spark-plug shell-and-wire assemblies.



from the ratio of total machine cost to annual direct-labor cost reduction is reflected in Fig. 1. Here actual unit product cost of a mechanized rotary-assembly machine is compared with a manual-assembly line.

For purpose of comparison, only that portion of burden affected by the change is shown in the chart, and machine depreciation is shown as a separate item. Material cost which did not change is omitted. It is obvious that the change in process resulted in a large reduction of direct-labor cost, which was more than offset by a greater increase in burden and machine-depreciation cost. Replacement cost of the old equipment was used, and a common depreciation rate was applied for comparison purposes. In this case the reduction in unit direct-labor cost multiplied by the number of physical units to be produced showed sufficient savings to justify the machine. In fact, the machine cost related to direct-labor savings reflected a machine pay-off period of $3^1/_2$ years. Return-on-investment method of justification reflected a negative 3 per cent return. Rate of return on investment not only provides the sound basis necessary for justification of a given project, but it also enables management to compare the rate of return to various other projects. This insures maximum economy in the total capital budget that is required.



Industry in general and General Motors in particular distribute burden on the basis of direct labor. The deficiencies of this method of costing have not been created by mechanization but instead have been enlarged. Fig. 1 illustrates the point.

Compared to the manual-line method, the rotary machine reflects an actual 53-per-cent reduction in direct-labor costs. Standard accounting practice would likewise reflect a 53-per-cent reduction in burden cost, and consequently a favorable investment picture. This method of burden distribution assumes that as direct-labor costs go so goes burden, actually the opposite is generally true.

Cost Study. Study covered detailed analysis of the old method of manufacture and the new mechanized methods. The analysis included such costs as direct labor, indirect labor, maintenance, perishable tooling, scrap, warranty, machine depreciation, and floor space.

The information used included down-time checks, time studies, standard time routings, machine repair, and tool-room records, inspection, production control, and accounting, together with other special reports developed for the study. Maintenance and down-time studies in particular were broken down to specific component parts of the machine.

Every case studied indicated that, as capital investment increases, maintenance costs also increase and higher skills are required on the part of the repairman. Repetitive maintenance on a particular mechanism was an indication that improvements in design were needed.

The in-line or straight-line type of design has proved to be superior to the rotary-type design. The former is more flexible in provision for additional stations which can accommodate modifications in operations, and is less costly to build and maintain. Also, there is better accessibility for set-up work, and less floor space is required.

As full mechanization is approached, usually automatic-hopper loading mechanisms are used to perform the functions otherwise done manually. However, these hopper-loading mechanisms can be troublesome and create costly down time due to jamming of faulty parts or a wrong application of the mechanism. In such cases a manual operation may be more economical than an automatic hopper.

Evidence of the advantages gained from both a sound economic-justification study and improvements in the design of mechanized equipment is portrayed in Fig. 2.

A new straight-line-assembly machine was used in the manufacture of spark-plug shells. Six operations were performed. Only those elements of cost affected by the change are shown in Fig. 2. The total product cost was reduced and the return on investment was in line with that forecast in the economic study.

Analysis of the cost chart on the straight-line method indicates that burden and machine-depreciation costs have become a greater per cent of the total cost than formerly was the case. Consequently, future cost reduction as well as cost control must place adequate consideration on these elements of cost.

Improvements in reduction and control of machine-depreciation cost per unit of production can be approached from several viewpoints. Four important ones are: (*a*) Reduce the cost to design and build a machine; (*b*) make it flexible so as to get the optimum in useful life; (*c*) develop an effective preventative-maintenance program, and (*d*) keep the machine running.

A machinery-utilization report developed by AC Spark Plug is an efficiency report on a machine, and is equally important to the control of cost as an efficiency report on direct labor.

Mechanization Plan

The most economical plan for mechanization can be determined only by comparing several combinations or alternate plans to the best manual method using existing facilities.

The economic comparison of the various plans must be predicated on return on investment, and this study must include all elements of product cost affected by the change. Because present-day accounting practices are inadequate, and burden distribution is inaccurate, cost data on burden must be obtained by special study.

It is evident that revisions in accounting methods to reflect realistic costs are overdue. If management is to be provided with the tools necessary to make wise decisions, and measure results accurately after fact, then present-day accounting practices must change.

Mechanization predicated on a sound economic study will reduce over-all product costs, improve quality, and provide a competitive advantage for the user.

After effective mechanization, cost reduction will place greater emphasis on material, burden, and machine-depreciation costs. This, undoubtedly, will result in the development of improved product design, different materials, lower cost machines, and new accounting and cost-control procedures.

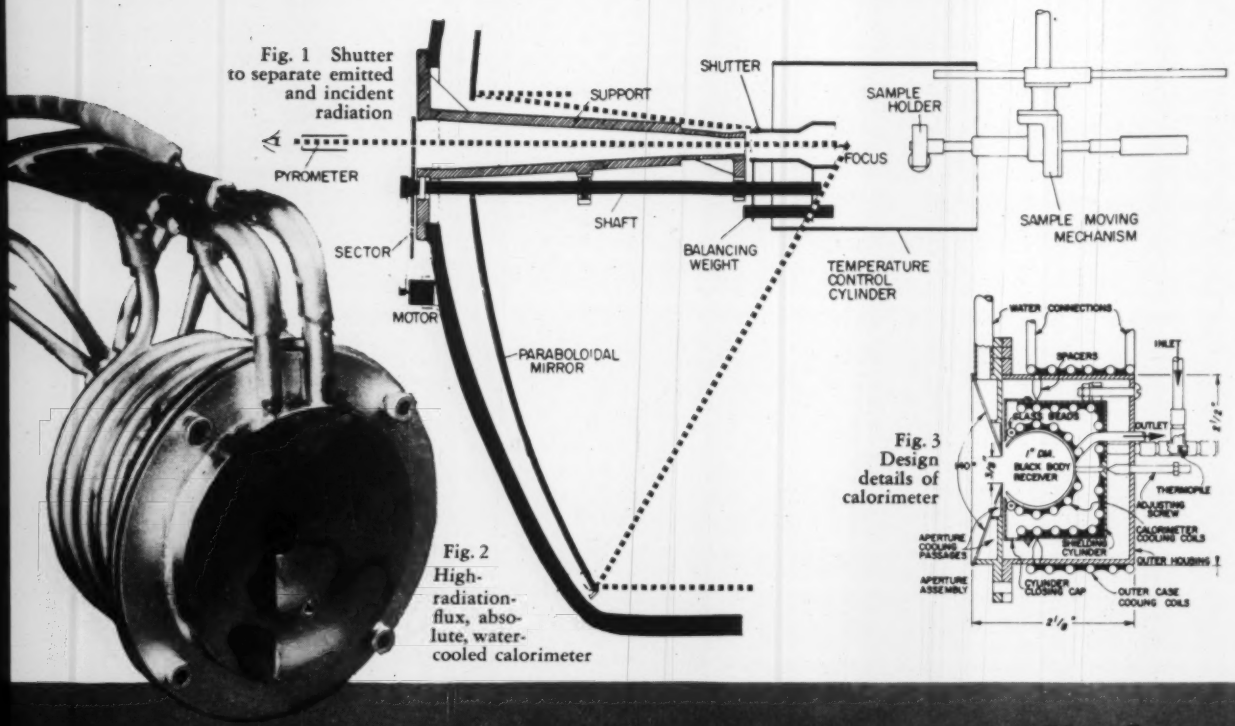


Fig. 1 Shutter to separate emitted and incident radiation

Fig. 2 High-radiation-flux, absolute, water-cooled calorimeter

Fig. 3 Design details of calorimeter

Engineering Research with a Solar

By P. E. Glaser, Mem. ASME, Research Engineer, Arthur D. Little, Inc.

ENGINEERS still have to make educated guesses regarding the behavior of materials under conditions of extreme temperatures and unfavorable environments. High temperatures must be generated under controlled conditions in the laboratory to test materials for gas-turbine, missile, rocket-motor, and nuclear applications.

One promising method of generating these temperatures is the use of an optical system to concentrate radiation from the sun in a solar furnace (1).[1] In the past few years, such furnaces have received considerable attention, and their basic principles, characteristics, and design features have been established (2). They have proved to be promising research tools for the measurement of high-temperature properties of materials and for materials testing (3), and nearly 40 of them are in existence in this country.

A solar furnace eliminates contamination of the sample by unfavorable environmental factors, since the heat source is far enough from the sample to transmit heat by radiation only, rather than by conduction or convection. In addition, materials can be tested either in air or in a controlled atmosphere, and measuring instruments can be brought close to the samples without being subjected to excessive heat.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Solar Energy Applications Committee and presented at the Annual Meeting, New York, N. Y., Dec. 1–6, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 57—A-261.

Physical Measurements

Although temperatures up to 3500 C could be conveniently generated in a solar furnace, methods of measuring physical properties at high temperatures had to be developed.

Temperature. Conventional optical pyrometers accurately measure only the temperatures of black bodies—a condition that few samples are able to satisfy.

A pyrometer that is now being developed will permit temperature and emissivity to be determined at the same time. The sample is viewed simultaneously by two radiation detectors at two different and unknown temperatures, and the ratio of each detector reading is recorded. The two ratios permit both temperatures to be derived from Planck's radiation law

$$\frac{\left(\frac{\Delta W}{W}\right)_{\nu_1}}{\left(\frac{\Delta W}{W}\right)_{\nu_2}} = \frac{\nu_1 \left(1 - e^{-h\nu_2/kT}\right)}{\nu_2 \left(1 - e^{-h\nu_1/kT}\right)} \quad \ldots\ldots [1]$$

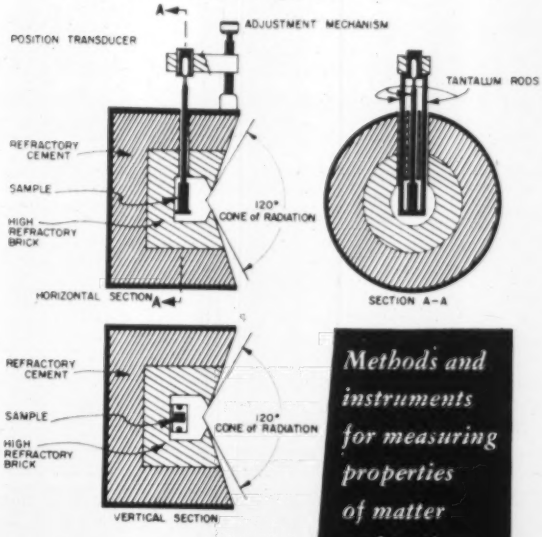
where

$\left(\frac{\Delta W}{W}\right)_{\nu_1}$ = fractional change in radiation at frequency ν_1 due to small change in temperature

$\left(\frac{\Delta W}{W}\right)_{\nu_2}$ = corresponding value for ν_2

T = unknown temperature

Fig. 4 Dilatometer for measurement of differential thermal expansion



Furnace
Cambridge, Mass.

Methods and instruments for measuring properties of matter and testing materials at high temperatures under laboratory conditions

A shutter, Fig. 1, is used in conjunction with this instrument to separate the emitted and incident radiation.

Heat flux. A high-radiation calorimeter, Fig. 2, is designed to measure the heat flux reaching the focal zone of the collecting mirror (4). This calorimeter can be exposed to flux densities of the order of 4×10^6 Btu per sq ft hr for extended periods without deterioration. The calorimeter consists of a black-body receiver provided with a cooled aperture and a cylindrical housing, Fig. 3.

The optical properties of the paraboloidal mirror cause a Gaussian distribution in the heat flux reaching the sample which can be measured with a water-cooled radiometer designed to withstand the high heat flux (5). The 0.1-cm diameter of the energy-receiving disk permits fine measurement of the flux distribution (6).

With these instruments, it is possible to calibrate a solar furnace under various conditions that relate incoming radiation energy (for example, measured with a pyrheliometer) to the radiation flux at the focal zone. Thus the necessary information on the sample exposure can be obtained without the installation of a calorimeter for an individual measurement.

Thermal Properties

Thermal conductivity. Obtaining reliable data on thermal conductivity in the moderate-temperature ranges is difficult, for the high-temperature ranges it is far more difficult, and hardly any information exists for above 1500 C. The following method, applicable to conditions in a solar furnace, may alleviate this condition.

The thermal conductivity and diffusivity of a poor conducting material can be obtained from the analytical solution of a heat-conduction problem (7). The temperature rise as measured along the axis of a circular-disk source can be expressed as

$$\theta(Z, t) = \frac{Q}{K}\left[2\left(\frac{\alpha t}{\pi}\right)^{1/2}\left(e^{-\frac{Z^2}{4\alpha t}} - e^{-\frac{a^2+Z^2}{4\alpha t}}\right) - Z\,erfc\,\frac{Z}{(4\alpha t)^{1/2}} + (a^2 + Z^2)^{1/2}\,erfc\left(\frac{a^2 + Z^2}{4\alpha t}\right)^{1/2}\right] \quad [2]$$

where

a = diameter of source
θ = temperature
Z = position along axis of disk source
t = time
Q = flux density
K = thermal conductivity
α = thermal diffusivity

From this solution, and on the assumption that thermal properties are independent of temperature, the temperature rise in a semi-infinite solid under the influence of a circular-disk source with a uniform and constant heat flux can be calculated.

The experimental procedure will be used to provide the temperature distribution along the axis at any time.

Let θ_1 and θ_2 be the two temperatures at corresponding distances Z_1 and Z_2 along the axis at time t_a. Then put

$$\eta = \frac{\theta_1}{\theta_2} = \frac{\frac{Q}{K} f(\alpha, t_a, Z_1)}{\frac{Q}{K} f(\alpha, t_a, Z_2)}$$

Provided that the temperatures are not too different, K will not vary significantly between θ_1 and θ_2.

Hence

$$\eta = \frac{f(\alpha_1 t_a, Z_1)}{f(\alpha, t_a, Z_2)}$$

From this, solve for α by successive approximations. On substituting α in Equation [2], thermal conductivity can be calculated at t_a and Z_1 or Z_2.

The value of thermal conductivity thus obtained corresponds to the temperature difference between the surface and the point inside the body. If a point near the surface is chosen, the temperature difference can be kept small, and approximate average values for thermal diffusivity and thermal conductivity can be obtained even when these properties show a weak dependence on temperature.

Thermal expansion. The measurement of thermal expansion at high temperatures is of considerable interest, particularly where refractory materials that may be subject to thermal shock are used. Such measurements can provide data on dissociations, allotropic transformations, and the formation of solid solutions.

A cavity-type dilatometer for measuring thermal expansion of materials is shown in Fig. 4. Heating the sample in a cavity (8) insures that most of the incident energy is captured. The temperature rises progressively as energy accumulates in the cavity; the maximum value is limited by conductive losses across the walls and the radiation through the cavity opening. The cavity temperature, and consequently the rate of heating or

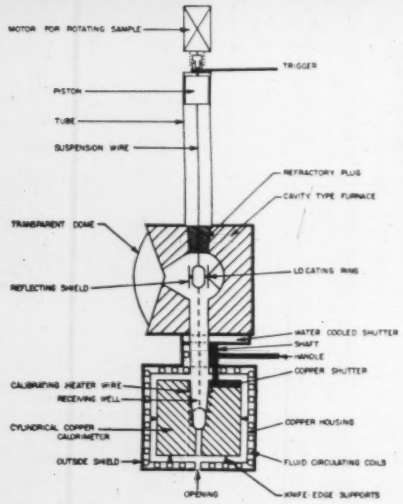


Fig. 5 High-temperature, aneroid calorimeter for heat-content measurements

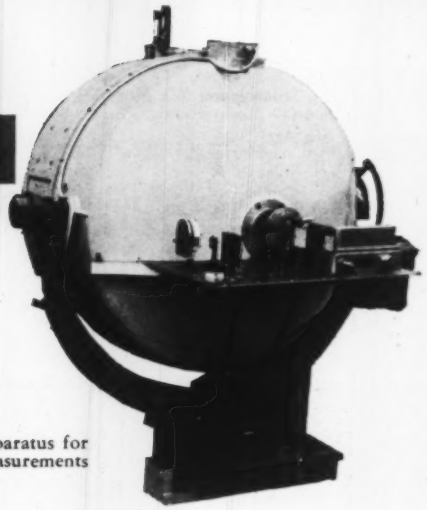


Fig. 6 Apparatus for emissivity measurements

cooling during a test run, can be very closely regulated by the admission of a greater or smaller amount of energy. The amount of radiation captured in the cavity permits the treatment of samples up to 2 in. long. The sample, in the form of a rod, is suspended by two tantalum rods in a cavity formed of high refractory materials. An additional tantalum rod is connected to a sensitive transducer to measure the thermal expansion of the sample. The sample can be tested in a neutral atmosphere or in a vacuum if a suitable window is used to close the cavity.

Heat content. Because of the physical difficulties of generating high temperatures in a controlled environment (9), few high-temperature heat-content data are available on the more common materials. Heating a sample in a cavity-type furnace by radiant energy, however, permits temperatures of about 2500 C to be obtained.

An apparatus designed for heat-content measurements in a solar furnace, Fig. 5, consists of two parts: A cavity-type furnace, in which the material is heated; and an aneroid drop calorimeter, where heat of fusion, heat of transition, and total heat content of substances can be measured.

The sample is contained in a suitable capsule held inside the cavity by locating rings and surrounded by a highly polished reflecting cylinder where the inside surface has been blackened to prevent uneven heating of the sample. The capsule is suspended by a pair of thin wires that also act as the thermocouple. For measurement of higher temperatures, an optical pyrometer can be used.

The suspension wires pass through a small hole in a refractory plug and are attached to a small piston. The piston, after release, is cushioned by the compression of the gas inside the tube; the sample is dropped into the calorimeter below the cavity.

Emissivity. The spectral emissivity of solid materials from the near-infrared to 15 microns can be measured conveniently in the solar furnace. In a typical study, the temperature range of interest extends from 1000 to 3500 K. The materials being studied include metals, refractories, and refractory-coated metals. The advantage of using the solar furnace is that the sample alone is heated and stray radiation from the furnace and other objects is completely excluded. Fig. 6 shows the apparatus in position on the solar furnace; a Perkin Elmer Universal Monochromator is used in conjunction with an optical system.

Materials Testing

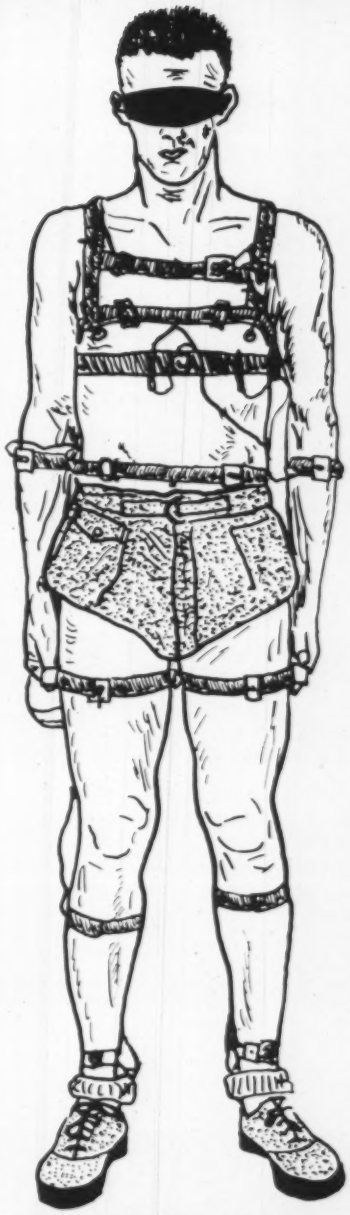
Solar furnaces have been used in a wide variety of tests to simulate conditions in extreme-temperature applications. The advantages are that the samples are heated in air, and close observation of the behavior of materials is possible.

Conclusion

At present only isolated literature references (10) have reported on experimental procedures for use in a solar furnace. As wider use of this research tool is made, the advantages of the solar furnace will be more fully realized, since the research possibilities are limited only by the ingenuity of the experimenter. Testing procedures now being developed will demonstrate that engineers not only have solved the problem of generating high temperatures, but also are able to solve research problems in the new field of pyrogenics.

Bibliography

1 Glaser, P. E., *Journal of Solar Energy and Engineering*, vol. 1, April-July, 1957, pp. 63–67.
2 Proceedings of Solar Furnace Symposium, *Journal of Solar Energy and Engineering*, vol. 1, April-July, 1957.
3 Conn, W. M., *American Ceramic Society Bulletin*, vol. 33, 1954, pp. 69–72.
4 Glaser, P. E., "A High Radiation-Flux, Absolute, Water-Flow Calorimeter," *Review of Scientific Instruments*, vol. 28, 1957, p. 1084.
5 Laszlo, T. S., *Journal of Solar Energy and Engineering*, vol. 1, April-July, 1957, pp. 78–83.
6 Gardon, R., *Review of Scientific Instruments*, vol. 24, 1953, p. 266.
7 Atalla, M. M., and Preston, K., *Journal of Applied Mechanics, Trans. ASME*, vol. 78, 1956, pp. 313–314.
8 Trombe, E., and Foex, M., *Metaux*, vol. 31, 1956, pp. 126–139.
9 Southard, J. C., *Journal of the American Chemical Society*, vol. 63, 1941, pp. 3142–3146.
10 Burda, E. T., editor, "Applied Solar Energy Research," Stanford Research Institute, Stanford, Calif., 1955.



MEASURING HUMAN EFFORT

Industrial medicine goes beyond the stop watch and the motion study to learn what happens to men in industry. At what point does the job become too much for the man?

By Lucien Brouha, M.D.[1]

E. I. du Pont de Nemours & Company, Wilmington, Del.

MODERN discoveries create new problems for man at work: Exposure to new chemicals, to radioactive substances, to dangerous dusts, excessive noises, extreme heat or cold, to new machines and new speeds of production.

In industry jobs are classified on the basis of time study, predetermined "motion times," and standard data.

The power and the efficiency of the worker's muscles, heart, lungs, his optimum rhythm of motions, his physiological working level and his speed of recovery during rest periods are essential factors that remain unknown. The stop watch is inherently unable to measure the physiological cost of a job.

The assessment of human effort is left to the judgment of an observer; consequently, inconsistencies and errors are frequent. Work and rest standards are arbitrary. They will remain so until the "physiological cost" of the job is measured—the only accurate means to evaluate the physical effort of the worker, to estimate his fatigue and to devise the steps necessary to keep fatigue within safe limits.

Scientists are building a new branch of the study of man; namely, "industrial physiology" or, in a broader sense, "occupational physiology."

Physiological Studies

Heart rate, blood pressure, cardiac output, pulmonary ventilation, oxygen consumption and carbon dioxide production, chemical composition of the blood and urine, water balance, and body temperature are all modified by muscular activity. By measuring one or more of these variables it is possible to determine by how much the "working level" differs from the "resting level." After activity ceases it is possible, by following the return of these variables to the resting level, to determine the duration of the "recovery period." When mechanical work stops, physiological work continues above the resting level until recovery is completed.

The determination of oxygen consumption is a method that has been used extensively, but the equipment is expensive and uncomfortable to wear; the number of workers who can be studied in a given situation is limited because the procedure is time-consuming. Furthermore, additional factors of physiological stress, such as heat and clothing, cannot be evaluated by oxygen consumption alone.

On the other hand, heart rate during work and during recovery from work is now recognized as an accurate means of evaluating physiological cost. The heavier the load, the greater the energy expenditure and the faster

[1] Physiologist, Haskell Laboratory for Toxicology and Industrial Medicine.

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Dec. 1-6, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 57—A-55.

MEASURING HUMAN EFFORT

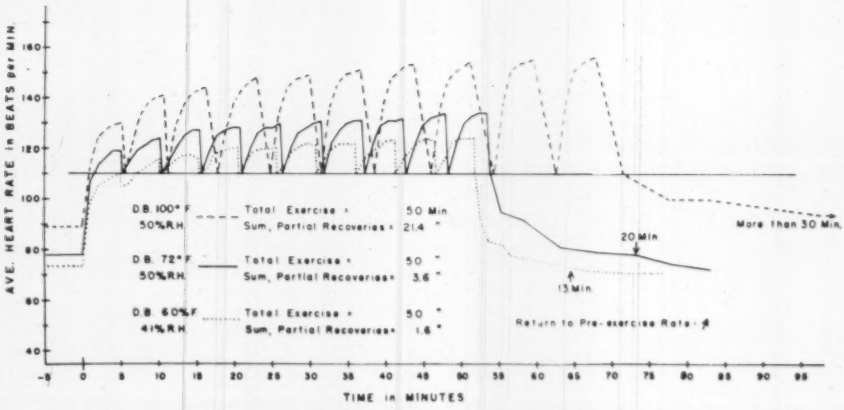


Fig. 1 Heart rates and recovery times in three environments. Subjects worked against a known load; temperature and humidity were controlled; for ten cycles of work, each cycle was followed by a return to a heart rate of 110 beats per min. If return takes more than one minute, accumulated fatigue occurs rapidly.

the heart rate (2, 3, 4).[2] During exercise "the pulse curve alone quite accurately depicts the physical state" (3). After muscular exertion the pulse rate also depends on the previous work load (5).

In addition, heart rate is influenced by the heat-regulating mechanisms of the body and it varies during work and recovery depending on the environment in which the work is done and the clothing worn.

Recovery Time

By measuring the time it takes to recover from work, a situation leading to physical fatigue can be evaluated. A man who cannot recover to a satisfactory level between work cycles will present increasingly higher physiological reactions, and fatigue will develop as the shift progresses. If fatigue is not too severe, it will completely disappear during the interval between two shifts and the man will report to work with a normal resting level of physiological reactions. If the work load is greater, the interval between shifts may not be long enough to insure complete recovery, and accumulated fatigue over days, weeks, or months may occur.

Wide variations are found in the physiological price that individuals have to pay to accomplish a given task (6, 7, 8). This variability is the result of numerous factors such as the innate potential of physiological mechanisms, age, health, and nutritional status, sex, and specific fitness for a given job and for a given environment.

Considering the range of individual variations, it is again obvious that no observer, regardless of his competence, can quantitatively assess human effort by judgment alone. The lack of precise knowledge about the workers' physiological reactions to the job is probably the most fundamental criticism that can be applied to the classic methods of work measurement.

In experiments, subjects worked on a bicycle ergometer against a known load in a room where the temperature and humidity were strictly controlled. Heart rate and oxygen consumption were recorded continuously before, during, and after exercise. Experiments showed that oxygen consumption was not affected by the environmental conditions. On the other hand, heart rate was definitely higher when the stress produced by a warmer and more humid environment was greater, and therefore it appears to be a more faithful index of physiological cost.

Fig. 1 gives the average heart-rate curves obtained under three environmental conditions. After ten work cycles, the recovery to the pre-exercise level was complete in 13 min at 60 F, in 20 min at 72 F, while at 100 F full recovery was not achieved with a 30-min rest.

Cardiac Cost

Cardiac cost during work is defined as the total number of heart beats above the resting level which is needed to perform work. The resting level is that observed while the subject sits still before the first cycle of work. Cardiac cost during recovery is the total number of beats above this level that occurs between the end of work and the return to the resting rate.

In tests, the cardiac cost for a standard amount of work increased as the environmental conditions became more severe. The cardiac cost during recovery followed the same pattern but the proportional differences between the moderate and hot environments were much greater as the number of work cycles increased. These experiments demonstrate the fallacy of standard rest allowances applied throughout the whole shift. Rest allowances should be flexible, and they need to be established on the basis of physiological measurements. In industrial situations where such varying environmental factors exist, owing to seasonal changes, for example, no measurement ignoring the physiological reactions of the worker would be sufficient either to estimate the difference in strain or to adjust adequately the rest allowances throughout the shift.

Effects of Clothing

Clothing in many instances produces an additional stress that cannot be assessed properly unless physiological measurements are made.

Fig. 2 compares the results that were obtained at the two extreme environmental conditions tested with and without heavy protective clothing. Vasodilatation of

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

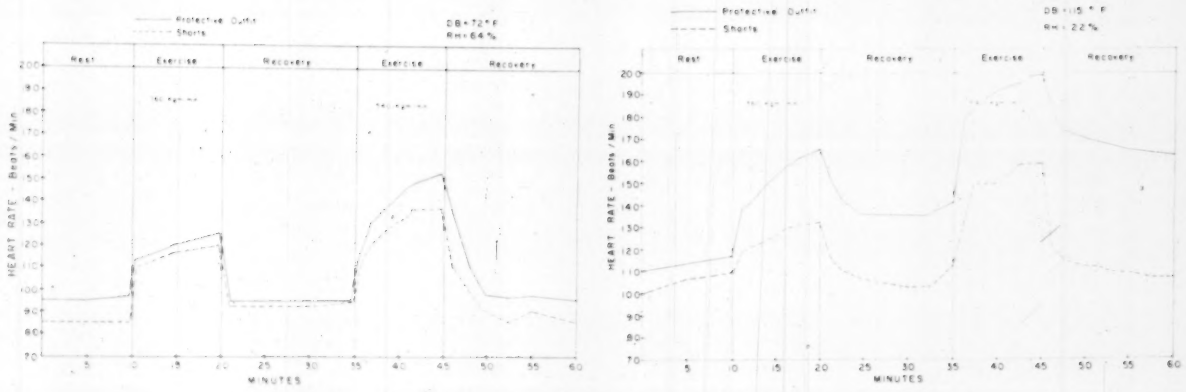


Fig. 2 The influence of protective clothing, as well as temperature and work load, on the heart rate. The areas between the lower dotted line and the upper solid line represent the additional physiological burden produced by clothing which interfered with the heat-dissipating mechanisms of the body.

the blood vessels in the skin occurred, resulting in more circulation at the periphery of the body for cooling in an effort to maintain normal body temperature. Thus in addition to maintaining an adequate blood supply to the working muscles, more blood had to be circulated; and this is achieved, at least partially, by an increased heart rate. Physiological measurements are the only means to determine accurately the additional stress imposed by clothing under these various conditions.

Stress Reduction

Physiological measurements are also needed to evaluate the stress reduction obtained by improving working conditions. Numerous examples supporting this have been studied in industrial operations (9, 10, 11, 12).

The true physiological cost will remain unknown unless physiological measurements are made during the recovery period.

Measuring the cardiac cost of work is impractical in the absence of laboratory facilities. In spite of the fact that telemetering devices have been developed which enable an observer to record continuously the heart rate of a man exercising in the field, this is still an exceptional and costly method. Fortunately for applied research, following the pulse rate variations after work is completed and, while the subject is recovering, gives valuable information about the amount of stress he had experienced during work. The principle of this method was developed in 1942 at the Harvard Fatigue Laboratory (5). It consists of counting the pulse rate by hand at regular intervals during the recovery while the subject is sitting quietly.

Usually the pulse is counted from 30 sec to 1 min after work stops, from $1^1/_2$ to 2 min, and again from $2^1/_2$ to 3 min (9). From these pulse counts a "heart-rate-recovery curve" can be constructed which indicates the actual pulse rates and the speed of recovery toward resting level. Both the physiological stress and the physical aptitude of an individual for a specific job can be determined from the recovery pulse rates. This kind of measurement is quick and simple as well as inexpensive, requiring only stop watches. It has been used extensively to evaluate the level of cardiovascular stress in industrial operations (8, 9, 11).

Physiological Fatigue

The onset of fatigue can be predicted from heart-rate-recovery curves. When no satisfactory recovery can take place between a series of successive operations, the first pulse rate after work becomes progressively higher and the heart rate remains at a high level for a progressively longer time during the recovery period. The return toward the resting level is very slow and definitely points to the existence of "physiological fatigue."

It has been our experience, over the past 12 years and in many industrial operations, that when the average value of the first recovery pulse is maintained at about 110 beats per minute or below, and when the decrease between the first and the third recovery pulse rates is at least 10 beats per minute, no increasing cardiac strain occurs as the day progresses.

Conclusion

When a well-co-ordinated and systematic program is developed, it will be possible to replace the notion of "mechanical work cycle" by the concept of "physiological work cycle." This will give a more accurate picture of the effort required by the worker and will furnish quantitative data for estimating fatigue.

Bibliography

1 Passmore, R., and Durnin, J. V. G. A., *Physiological Reviews*, vol. 35, 1955, p. 801.
2 Hill, A. V., and Lupton, H., *Quarterly Journal of Medicine*, vol. 16, 1923, p. 135.
3 Bock, A. V., et al., *Journal of Physiology*, vol. 46, 1928, p. 149.
4 Dill, D. B., and Brouha, L., *Travail Humain*, vol. 5, 1937, p. 1.
5 Johnson, R. E., Brouha, L., and Darling, R. C., *Revue Canadienne de Biologie*, vol. 1, 1942, p. 491.
6 Brouha, L., Graybiel, A., and Heath, C. W., *Revue Canadienne de Biologie*, vol. 2, 1943, p. 86.
7 Brouha, L., Fradd, N. W., and Savage, B. M., *Research Quarterly*, vol. 15, 1944, p. 211.
8 Brouha, L., and Ball, M. V., *Revue Canadienne de Biologie*, vol. 7, 1948, p. 479.
9 Brouha, L., *Advanced Management*, vol. 19, January, 1954, p. 9.
10 Brouha, L., Transactions 12th Meeting of the Industrial Hygiene Foundation, Pittsburgh, Pa., November, 1955.
11 Brouha, L., Proceedings 11th Annual Management Engineering Conference, New York, April, 1956, p. 129.
12 Brouha, L., Proceedings 9th Annual Industrial Engineering Institute, University of California, February, 1957, p. 12.

Summary of Important

1 Removal of impurities from a gas requires development of relative motion of particles through the gas.

2 Production of relative motion requires application of force to particles, and consumes energy. Economic evaluation of a particular device obviously is based on efficiency and energy consumed.

3 Forces and resulting motions may be random or directed relative to main gas stream, but finally must result in motion toward surfaces or regions from which particles may be separated from gas stream.

4 There is no theoretical minimum energy required to separate discrete particles from a gas stream, such as there is for separating gaseous impurities.

5 Most separation processes tend to be more effective when used for certain types or sizes of particles than for others.

6 For efficient cleaning, all portions of gas must receive the same uniform treatment, in so far as possible.

7 Gases which contain condensable or precipitating impurities must be allowed to complete condensation or precipitation before cleaning.

8 Particles of size in the order of 0.1 mu are the most difficult to remove by inertial and diffusional methods.

9 Specifications for gas cleaning should take into account amount of impurity to be removed and size of particles.

10 Special properties of particles, such as electrostatic charges, wetability, and so on, must be considered.

FOR the development of gas-cleaning equipment, and the selection of the right equipment for a specific job, the engineer needs an understanding of the basic principles of gas cleaning. The principles are simple enough; complexity comes in the extensive range of variables.

Variables include the type of impurities to be removed, the concentration of impurities, the sizes of particles, and the properties of the gas to be cleaned.

Elements of the Problem

Impurities. They may be:

1 Other gases—of high or low molecular weight, chemically active or inactive, with specific electrical, magnetic, and radioactive properties, and with solubilities in various possible absorbents.

2 Liquid droplets of varying size, surface tension, and rate of coagulation, also possibly chemically active, or with a tendency to absorb water vapor, and often electrically charged.

3 Solid particles of varying size, shape, and density, with most of the other properties mentioned under gases and liquids.

4 Certain special types of impurities which may change their phase (gas-liquid, gas-solid, or liquid-solid) and/or their chemical composition with time, temperature, or other physical changes.

The concentration of impurities in the initial gases and the final cleaned gas may vary from a small percentage of the total gas stream down to a fraction of a part per million. Although it is customary to express the efficiency of gas-cleaning equipment as the percentage of the initial concentration in the final gas, this is seldom what the engineer is really interested in. What is usually required is the answer to the question: Is the gas suitable for further processing, or for discharge into the atmosphere without creating a nuisance?

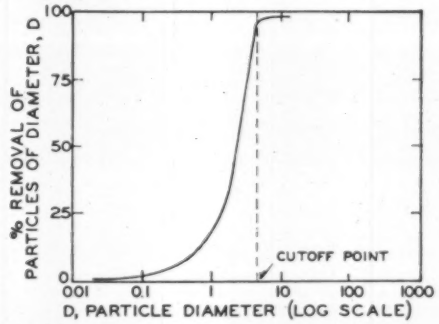
Thus a certain low concentration of sulfur dioxide in an industrial district might be tolerated when the equivalent in sulfuric droplets would be highly undesirable. Likewise, gases to be compressed in certain types of compressors might be permitted a certain weight of submicron particles, which would be intolerable in the form of 10-micron particles (see section, "Criteria"). In any event, the concentration of impurities must be considered in relation to the nature of the impurities.

Particle size. In the case of liquids, particle size is essentially the diameter of the liquid droplets, though to be consistent it should be modified for liquid density, surface tension, and possibly viscosity. In the case of

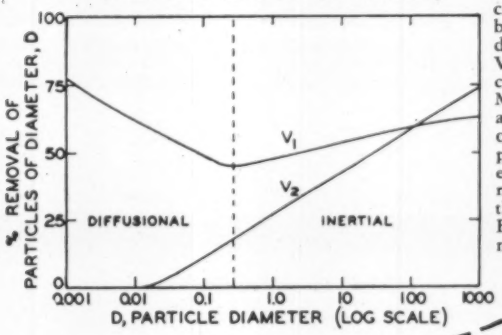
[1] Consultant, Stoneham, Mass.

Contributed by the Committee on Air Pollution Controls and presented at the Annual Meeting, New York, N. Y., Dec. 1-6, 1957, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 57—A-270.

Principles



◀ Fig. 1 Typical performance of gas cleaner using inertial force to separate particles. Below the critical point, particles will be removed in percentages approximately proportional to their diameters.



▼ Fig. 2. Gas cleaner which uses both inertial and diffusional forces. Velocities remain constant, $V_2 > V_1$. Minimum performance efficiency occurs at the particle diameter corresponding to the onset of Brownian motion.

GAS CLEANING

By R. V. Kleinschmidt,[1] Mem. ASME

To remove impurities from a gas, you produce relative motion between the particles and the gas, concentrating the impurities. How? And how is ultimate separation accomplished? Here are the principles of gas cleaning.

solid particles, which are seldom spherical, a shape factor also must be included.

The gas to be cleaned. Its properties include density, viscosity, chemical and electrical properties, and temperature.

The Cleaning Process

Basically, the mechanism of gas cleaning consists in causing the impurities in the gas to move through the gas so that they concentrate in a region from which they may be removed. Thus the basic requirement is the production of relative motion between the particles and the gas. (Here, "particles" is used to include molecules as well as discrete solid or liquid particles.) Such motion involves the application of forces on the particles. These forces and the resulting motions may be either random or directed. However, at least the last portion of the cleaning process must involve directed forces and motions out of the gas stream and toward the walls of the gas container or passage.

We have, then, two steps in the cleaning process: The concentration of the impurities by relative motion through the gas, and the removal of the concentrated impurities from contact with the gas stream.

The forces that may be employed to cause relative motion include:

Electrostatic. With this method, the major problem is in the second stage of cleaning; namely, the removal of the impurities concentrated from the gas stream from the electrodes, and the cost and complexity of the equipment.

Magnetic. So few materials are strongly magnetic that this method of separation is scarcely worth discussion. Basically, it would present much the same problems and properties as electrical precipitation.

Gravitational. Although gravitational forces are a major factor in removing particles larger than about 100 microns, especially from slow-moving gas streams, they become negligible in comparison with available inertial forces in high-speed gas streams and for finer dusts.

Mechanical (filters). These may be true filters or "strainers," depth filters (which consist of a mass of fibrous or granular material of considerable depth, in which particles become lodged and retained), or viscous filters (which are depth filters having the passages coated with a sticky or oily liquid).

Inertial. This is the most widely used method of particle removal. The forces used are generally produced by changes in the direction of flow of the gases, by the general rotation of an entire stream of gas, or by turbulent rotation within the gas, as in the turbulent boundary layer. Change of direction may be caused by an obstacle in the flow path or by projecting through the gas a solid or a liquid particle. This last case, which represents the method of gas cleaning commonly referred

to as "scrubbing" with liquid droplets, has been treated by the author.[2]

Two Types of Mechanism

It will be noted that there are two types of mechanism involved—one which may be called the positive type, in which substantially all of the particles larger than some fixed (designed) size will be removed (as, for example, in true filters or screens); and the other, which may be called the "probability" type, in which a certain amount of treatment will be expected to remove a certain fraction of the impurities of a given size or kind. The latter is the more common case and holds for scrubbing with liquid drops, for viscous filters, and to a large extent for depth filters and for gas absorption in liquids or in beds of solids.

For any given design of inertial gas cleaner there will be a certain average distance that particles must move through the gas in order to be removed from the gas stream. Thus there will be practically complete removal of particles which are large enough to move more than their average distance in the time allowed for treatment. Particles smaller than this critical size will be removed in percentages approximately proportional to their diameters. This gives a characteristic curve such as that in Fig. 1 for this type of cleaner. Such curves are well known and have been used to support the erroneous belief that certain types of cleaners cannot clean a gas to a concentration of the contaminant below the break point, whereas, actually, they only show the design break point for a particular unit.

Electrostatic forces tend to be more nearly proportional to the surface area of particles, and hence electrostatic precipitators tend to remove all sizes with equal efficiency. Thus they are relatively more effective for fine particles than other types of gas cleaners.

As particle diameters decrease into the submicron range, the simple relations just stated no longer hold. The dust particles begin to exhibit "Brownian movement"; that is, the motion caused by impact of gas molecules. This produces motions of the dust particles relative to the gas, and although these motions are completely random, on the average they aid in the removal of the particles. Thus for a given velocity of gas through a cleaner, we expect that there should be a minimum in the performance efficiency at the particle diameter corresponding to the onset of Brownian motion, as shown in Fig. 2.

There are no completely uniform sprays, no completely uniform electrostatic fields, and no uniform rates of flow at every point in any gas passage. Nonuniformity is probably the most insidious enemy of high efficiency in gas-cleaning equipment. When high over-all removal of impurities over a long period of time is required, as in the removal of a nuisance, any down time of the scrubbing equipment is, in effect, a bypassing which may seriously lower over-all efficiency.

Energy Consumption

The amount of energy required for a given cleaning job is not a fixed minimum but depends on the time available for the cleaning, and on other factors. Although attempts have been made to show a relation between pressure drop (energy per cubic foot of gas) and effectiveness of cleaning, it can be shown readily that there is no theoretical basis for such a relation. Any apparent relation merely represents a kind of commercial optimum relation between equipment size and cost, and efficiency. However, any given type of gas cleaner, especially of the inertial type, will require more power as the effectiveness of cleaning and the removal of finer particles is increased.

The final removal of the concentrated impurity from the gas conduits often presents some major problems. Continuous removal of dry dust involves the removal of a fraction of the gas stream as well, or incomplete removal of dust with the possibility of remixing of dust into the gas stream. An example of this is in the cleaning of dry electrical precipitators. Possibly the simplest method of the final removal of dust is in a liquid which can be separated completely from the gas stream.

In the case of filters and in most dry-removal devices, especially with very fine dusts, periodic removal or "cleaning" is required. This is practical only when the amount of dust collected is small.

Special Cases

One of the most troublesome of the special cases is the removal of an impurity which is being condensed or precipitated. Examples are: the removal of tar fog, the precipitation of iron from iron carbonyl, and the removal of sulfuric mist. In such cases, cleaning cannot be effective until the reaction of condensation is complete and the droplets are grown to the maximum size they will attain. In these cases, "delay chambers" and preliminary treatment by cooling and humidification may be necessary.

A special case of agglomeration is the use of a fibrous mat for agglomerating liquid fogs. In this, fog particles build up on the fibers until they are large enough to be blown off as relatively coarse drops which can be removed easily by settling, centrifugal action, or scrubbing.

The absorption of gases may be considered as the limiting case of removing very fine particles in which molecular motion provides the "relative motion" and inertial forces are negligible. The principal factor here is the rate of diffusion of the gaseous impurities through the gas and through the absorbent (usually a liquid), the latter often being a determining factor.

Criteria

Several criteria for cleanliness are possible. For the removal of a nuisance, the appearance of the effluent gases to the eye may be important. In this case the very fine particles may be the worst offenders, and cases have been known where removal of 95 to 99 per cent of the total solids content of an inlet gas stream has made only a barely detectable change in the appearance of the "cloud" of dust. Another criterion is the "fallout" or deposition of dust in the neighborhood of the discharge point. In this case, the larger particles are the worst offenders. (Acid mists are often judged by this criterion.) Whatever the basic criterion, it should be reduced to specifications of percentage removal, or maximum dust loading in various size ranges, or else specified by the ultimate result desired.

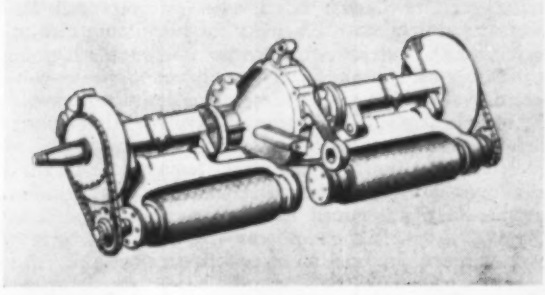
[2] *Trans. ASME*, vol. 63, May, 1941, p. 349.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD

Gas-turbine-powered vehicle for towing large aircraft



Turbo-Tug's low silhouette allows it to slip under the plane where it is attached by a hydraulic coupling device. Friction drive rollers supply traction directly to the rubber-tired wheels of the plane. The vehicle becomes an integral part of the aircraft and is maneuvered by the pilot. The front wheels of the vehicle do the steering; the steering mechanism also being under the pilot's control. A second gas turbine in the vehicle furnishes starting capacity for the main aircraft engines. There is no noise, dust, or propeller hazard as there is when taxiing with the plane's own engines, and greater maneuverability is afforded with the added advantage of being able to reverse.

Turbo-Tug

TOWING large jet aircraft with a conventional tractor has become impractical because of the weight of the vehicle required, tow-bar loads, the low silhouettes of the newer planes, and the difficulty of maneuvering aircraft by tow bar.

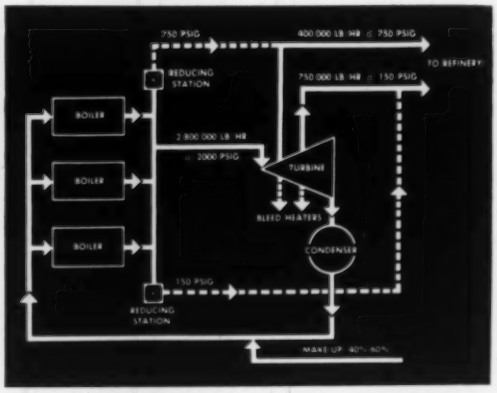
Turbo-Tug, a lightweight, low-silhouette, gas-turbine-powered vehicle that would overcome these difficulties is in the prototype stage and nearly ready for commercial production by Napco Industries, Inc., Minneapolis, Minn. The 47-in-high vehicle which weighs only 9000 lb slips directly under the aircraft and is attached to the main-landing-gear axle. The traction needed is supplied by direct friction drive between the tug drive rollers and aircraft main-landing-gear wheels. The full weight of the aircraft is thus used for traction. Modular construction and the use of standard aircraft components are other advantages.

Once Turbo-Tug has been coupled to the landing gear of the aircraft by the 6-way hydraulic coupling hook—an operation which takes only 10 or 15 sec—it becomes an integral part of the aircraft and is controlled by the pilot. He maneuvers his craft as he would in taxiing, with the added advantage of being able to reverse. Disk brakes on the Turbo-Tug can stop the aircraft if hydraulic-braking pressure is lost in the aircraft braking system.

The Turbo-Tug is powered by a Boeing Model 502-10C gas turbine which has a dry weight of 320 lb, a normal rated torque of 435 ft-lb, and delivers 240 normal continuous bhp and 270 bhp max. The $4^1/_2$-in-long, 24-in-wide, and $24^1/_4$-in-high gas turbine requires no warm-up and achieves full rated power 15 sec after starting. The power delivered is sufficient to move aircraft having a gross weight of up to half a million pounds.

Through the use of a second integrally mounted gas-turbine engine, a Boeing Model 502-11B gas-turbine compressor, the Turbo-Tug has the built-in capacity to start the main aircraft engines.

Public Service's Linden generating station swaps process steam with Esso Standard Oil's Bayway Refinery for residual fuel to achieve a new record in thermal efficiency of 54 per cent



Unit 1 has three identical boilers to insure reliability of process-steam supply. Two boilers are sufficient to operate with full extraction flow from the turbine.

Linden Generating Station

An exchange of process steam for fuel and boiler feedwater between Public Service Electric and Gas Company of New Jersey and the Esso Standard Oil Company has resulted in a record thermal efficiency of 54 per cent at the new Linden Generating Station. This is in a 550,000-kw plant with two units, one capable of 2,800,000 lb of steam per hr and the other 1,820,000 plus an extraction of 1,550,000 lb per hr of process steam for the refinery.

Electricity is also supplied to the refinery and a favorable load factor was a major consideration in Public Service's decision to undertake the co-operative project which represents nearly one quarter of the previous generating capacity and an investment of $100 million.

An assured supply of low-cost residual fuel that is solid at room temperature but becomes fluid around 450 F is the basis of what the companies call the "big swap." At present, heating for a 100-deg rise from the 350-F delivery temperature is the only treatment the fuel requires and viscosity is automatically controlled by a viscosometer. An additive system has been incorporated into the design for future use.

None of the principles applied in the Linden plant are new. However, the size of the equipment, the magnitude of the throttle and process flows, and the high operating economy constitute a significant forward step in steam power-plant engineering.

The steam conditions at Linden are about the same as those of other recently installed units, but the improved economy is brought about by two unusual uses for low-level heat energy that is normally rejected to condenser cooling water: (*a*) The heat required for oil-refining processes; and (*b*) the heat required to raise the temperature of that part of the unusually large feedwater flow which is the make-up due to the delivery of extraction steam for refining processes.

In the past, the price of higher economy has been higher steam conditions and the added complications of such features as reheat, pressurized furnaces, and gas recirculation. At Linden, the price of the high economy lies in the additional complications of: (*a*) Automatic steam extraction from the turbines; (*b*) a water-treating plant for high make-up; (*c*) the special features for handling and burning high-viscosity fuel; and (*d*) the provisions to insure the reliability of the steam supply.

Reliability was a must for the critical refinery operations and in addition to the use of a 3-boiler setup for the first unit is guaranteed by duplicate systems in almost all components, as well as three sources of emergency power, and a Bunker-C backup fuel provision.

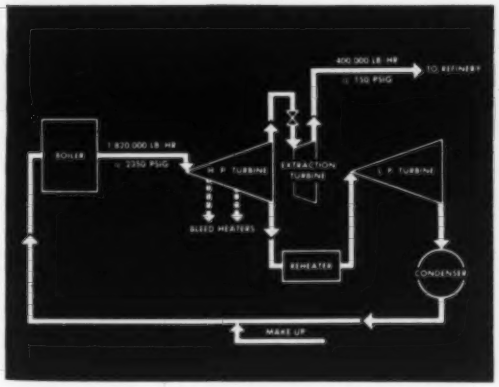
The contractual arrangement between the two companies provides that Public Service will deliver to Esso the entire steam requirement of the Bayway Refinery in exchange for fuel and raw water. The additional fuel required to operate the units at full electric output is to be delivered by the refinery at commercial rates. The basic fuel for both commitments will be the high-viscosity residual fuel. When there is not enough, the deficiency will be made up by the Bunker-C fuel oil. Electric energy will be delivered to the refinery at regular wholesale rates. The contract runs for twenty years with provision for extension.

Design concepts. The arrangement of three boilers supplying one turbine, which is unusual today, was chosen with reliability of steam supply in mind. Two boilers are sufficient to operate the unit with full extraction flow from the turbine.

Throttle steam conditions of 2000 psig and 1050 F were chosen for the first unit as a design compromise between reliability, cost, efficiency, and optimum turbine design for the extraction of process steam. With three boilers, a steam turbine, and two turbine bypasses connected to a double steam header, it was desirable to avoid the complications of reheating and the higher cost of a steam piping system with austenitic steel valves. Therefore the upper limit for the steam temperature was set to allow the use of ferritic steels. The throttle steam pressure was determined from the exhaust conditions necessary to satisfy the requirements of the refinery.

Since the dependability of process-steam supply had to be designed into the first unit, the approach to the design of the second unit was more in the direction of the concepts used in other recent installations—that is, high steam temperature, steam reheating, and a single boiler for the turbine-generator. However, this second unit was also designed to furnish extraction steam to the refinery at the lower of the two pressures to meet increasing steam demands of the refinery as it grows.

A 6300-ft run of pipe from the boilers of Linden Generating Station delivers steam to the existing Esso Boiler



Unit 2 can also furnish extraction steam but design is similar to that for other recent installations—high steam temperature, reheat and single boiler

House from which it is distributed to the refinery. There will be two 30-in. lines for low-pressure steam, two 16-in. lines for high-pressure steam, one 8-in. line for high-viscosity fuel, one 10-in. line for Bunker-C fuel, and one 16-in. line for raw water, with a 16-in. connection to the Elizabethtown Water Company.

The Linden control room contains all the usual central controls for the two turbine-generators and the four boilers, and in addition, all the controls for the extraction-steam and pressure-reducing stations. The complete station operation, except the water-treatment equipment is handled from this point. There is a separate control system located in the water-treatment section. Further details are given in ASME Paper No. 58—SA-36, by M. A. Eggenberger and P. G. Ipsen, "The Control System of a 225,000-kw Double-Automatic Extraction Steam Turbine and Related Reducing Stations," to be presented at the Semi-Annual Meeting, Detroit, Mich., June 15–19, 1958.

Turbines. The turbine of unit 1 is record-breaking in at least two respects. The throttle steam flow of 2,800,000 lb per hr which corresponds to a rating of 425,000 kw in a straight-condensing conventional-reheat machine, was the largest in the world when operation started. The rating of 225,000 kw made it the largest automatic double-extraction turbine ever built.

The second generator will be driven by a 225,000-kw, 3600-rpm, tandem-compound, triple-exhaust-flow, automatic single-extraction turbine. Throttle steam conditions are 2350 psig and 1100 F with reheating to 1050 F being used.

Fuel systems. Mechanical atomizing, wide-range, recirculating-type burners will provide a high degree of remote manual operation. The boilers are expected to be capable of a 5 to 1 range of output without removing or inserting burners.

The high-viscosity fuel will be supplied to the burners at about 1000 psig and 450 F. At this temperature its flow characteristics will be about the same as Bunker-C fuel. The system is designed on the assumption that the fuel will solidify at 275 F. Steam tracing will heat the entire length of the large lines as far as the boiler stop valve.

From that point to the burners, electric resistance heating of the pipes themselves will be used. Each furnace is expected to demand 100 amp at 22 volts and 60 cycles. The steam for the tracing will be taken from the high-pressure extraction-steam system.

Plant design was entirely by the Electric Engineering Department of Public Service. Builders were United Engineers and Constructors, Inc. Alfred Easton Poor was architectural consultant.

Boiler for Low-Volatile "Char"

BOILERS capable of generating steam efficiently by burning a new type of low-volatile char are being developed by The Babcock & Wilcox Company.

The new equipment is considered a major breakthrough in the continuing search for ways to reduce fuel costs for power production.

The char obtained from the new processes is not a premium fuel, and can be used economically for power generation. In addition, coal-tar products, chemicals, and gases that will be equal in value to that of the coal itself may now be removed by advanced methods.

Test burning of this fine, cokelike residue has been carried on with highly favorable results for nearly two years at B & W's Research and Development Center in Alliance, Ohio. Although removal of the readily volatile material makes it more difficult to burn in a furnace than raw coal, char is claimed to have approximately the same heat value.

Three units are currently being installed at the Ohio Power Company's giant new Kammer Station in Cresap, West Va. Each unit will have a design pressure of 2400 psi, and steam and reheat-steam temperatures of 1050 F. Their combined steam output will total 4,569,000 lb per hr.

A feature of these boilers will be the use of dual-proportioning feeders to permit the firing either of 100 per cent coal or 100 per cent char or any proportion of the two. This proportioning feature will assure continued ignition stabilization through the addition of bituminous coal as required in the event it is desirable to vary the volatile content of the char. It will also permit uninterrupted boiler operation when the char plant is not operating. Each boiler also will be equipped with five Cyclone Furnaces. Use of these furnaces permits the utilization of a standard boiler and furnace design for firing both char and bituminous coal interchangeably. Char can be burned in the Cyclones at the same heat-release rates and with the same air pressure required for bituminous coal.

Scheduled for completion this year, the Kammer Station will generate a total of 675,000 kw of electricity per hr. This power will be used primarily to operate a huge aluminum-reduction plant being built a short distance down the Ohio River from Kammer by Ormet Corporation, which is owned jointly by Olin Mathieson Chemical Corporation and Revere Copper and Brass, Inc. Power also will be supplied to the adjacent Olin Mathieson aluminum rolling mill. Ormet owns two of the boilers, while Ohio Power Company, which will operate all three units, owns the third.

Also associated with the power-plant operation is a mammoth project of the Pittsburgh Consolidation Coal Company. Its new 3 million-ton-per-yr mine, being opened in a nearby mountain, will supply the raw coal for its projected $25-million processing plant, which will extract the chemicals from the coal before it is burned in the boilers as char.

Muffler Eliminates Noxious Fumes

A POSSIBLE SOLUTION to the problem of noxious gasoline-engine-exhaust fumes in closed plant areas is offered in the form of a new, insulated catalytic exhaust purifier, or muffler, that eliminates up to 90 per cent of the carbon monoxide and other fumes. The Oxy-Muffler, developed by Oxy-Catalyst, Inc., of Wayne, Pa., enables fork-lift trucks and other gasoline-powered equipment to be operated with greater safety to personnel inside the plant.

The muffler consists of a number of chambers, each containing beds of tiny catalyst pellets. When the exhaust fumes from the gasoline engine enter the unit, a venturi in the inlet section sucks air through a filter to support combustion of the exhaust contaminants. The hot gas flows through the pellet beds and combines with oxygen, by catalytic chemical action, into carbon dioxide and water vapor.

Even in poorly ventilated areas the exhaust clean-up may be sufficient to eliminate the annoyance factor, and, in many cases, the danger from noxious engine fumes.

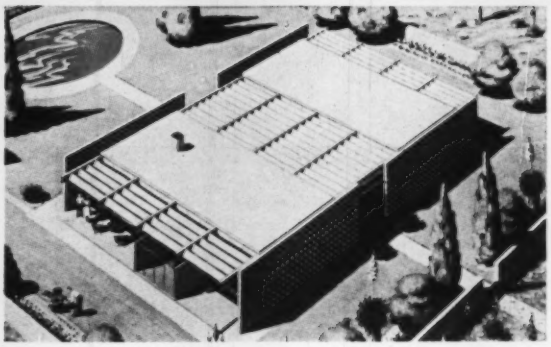
Because the muffler operates at temperatures ranging from 1000 to 1400 F, a good insulating jacket is essential. Oxy-Catalyst selected Johns-Manville's Cerafelt refractory-fiber insulation.

Cerafelt is made by converting molten refined refractory minerals into a mass of extremely fine, uniform ceramic fibers that possess good resiliency. The result is a tough, lightweight insulating material that will withstand continuous exposure to operating temperatures up to a full 2000 F, and perform satisfactorily for the life of the muffler under conditions of high temperature and severe vibration. Low thermal conductivity and excellent chemical stability are additional identifying characteristics.

Cerafelt not only conserves heat inside the muffler, but provides an outside temperature low enough to prevent burning of personnel who come into contact with the muffler.

This muffler, designed to replace the truck's acoustical exhaust muffler, can be installed on any standard industrial vehicle and was specifically developed for use with leaded gasoline. There are three basic sizes for engines with piston displacements ranging from 0–75, 76–150, and 151–230 cu in.

Oxy-Catalyst also manufactures a purifier for use with 4-cycle diesel engines insulated with Johns-Manville's Thermobestos blocks. This completely inorganic insulating material, effective at temperatures up to 1200 F, is available in precut shapes and was selected because of its high thermal-insulating qualities and availability in precut shapes.



Solar-Heated Homes

A SOLAR-HEATING SYSTEM of a type which can now be used in American homes in two thirds of the nation will pay for itself in less than ten years.

John I. Yellott, Mem. ASME, executive vice-president, Association for Applied Solar Energy, said the basis for this estimate is the Solar House which was officially opened to the public near Phoenix, Ariz., in April. The system as installed in this house costs approximately $4000 more than a conventional heating and cooling system.

It is estimated that heating and cooling the house through conventional methods would cost $1000 a year, whereas with the solar system the cost will be only $450 annually including maintenance.

All mechanical equipment being used in the Solar House is now available through commercial sources and is economically feasible for new construction in all but the eastern part of the country, Mr. Yellott said. Solar energy will provide winter heat for the house and swimming pool, and will heat the domestic water supply throughout the year. Heat is stored during sunny periods to use in cloudy spells.

Construction of the demonstration Solar House was a project of the Association for Applied Solar Energy, an international nonprofit scientific organization. Though the house is in the $50,000 bracket, Mr. Yellott emphasized that similar solar-heating equipment could be installed in virtually any new home costing as little as $10,000.

Another low-cost model Solar House with the heating system designed by Mr. Yellott has been constructed in Casablanca, French Morocco, as a part of the U. S. Department of Commerce Exhibit at the Casablanca Trade Fair. Solar heating offers particular promise for fuel-short areas of the world where sunshine is plentiful, and provides a means of conserving the world's dwindling supply of fossil fuels.

In addition to using the sun's energy for heating, the Solar House incorporates a unique solution to the related problem of minimizing the cooling load during the summer. The solar collectors are utilized as shade-producing louvers. Integrating the swimming pool with the air-conditioning circuit allows the heat pump to operate with maximum economy in both winter and summer.

The Arizona Solar House gathers solar energy by means of a series of collector panels which are turned to face the sun each day. At night and during the summer, they are rotated so that their aluminum-clad backs face the sky. Water circulated through copper tubes in the collectors is heated and stored in an underground tank, providing a reserve of heat for use at night and during cloudy weather. This heat is transferred into the house as needed by coils mounted on the intake faces of two standard air-to-air heat pumps.

Controlling Production

CONTINUOUS DISPLAY of accurate and up-to-the-minute figures on current production is provided on the central control panel of a system produced by the Control Systems Company, a division of Hancock Industries, Inc., Jackson, Mich.

Each production station or machine in the plant has its own display on the control panel. Machine sensors count the production of each part and display the figure on mechanical counters in the control room. Down time is also recorded, and any interruptions are signaled in lights. Where limited production of a part is required, a balance counter may be set before the start of the run to flash a green light and sound a beep signal when the desired total has been reached.

At the end of a shift the dispatcher can clear all the control cabinets in the dispatch room in as little as 15 minutes. He uses a 5-channel tape add-punch machine to read off information from the individual registers. Once the information has been read off, registers are nulled and the equipment is set up for the next shift. Information can then be passed to the accounting department or other management division. Data are received and handled much faster than with conventional paper work.

As soon as trouble is indicated on the control board, the foreman is signaled. The system permits him to remain on the floor near production areas where closer supervision can be maintained and trouble spots can be reached quickly. A portable telephone handset that plugs into jacks at the various machine locations provides communication with the dispatch center.

Wood Products of the Future

"FORESTS comprise our only renewable material resource" for major production materials. What will their place be in our future economy—in the age of metals and their alloys, and of plastics and other products of the great chemical industries?

L. J. Markwardt, assistant director of the United States Department of Agriculture's Forest Products Laboratory, Madison, Wis., has assayed the role of forests, and the importance of research, in a paper contributed by the Wood Industries Division and presented at the 1957 ASME Annual Meeting as a luncheon address.

Shortly after the turn of the century, lumber reached a level of per capita consumption which, the author states, "we cannot again expect to equal, nor shall we need to." Judged by present standards, lumbering was then a wasteful process where only one third of a tree found its way into lumber. In spite of keen competition, wood has maintained a major place among materials. The Navy used more wood than steel, by volume, during World War II.

Wood is such an old material and has so many common uses that it is too frequently taken for granted. "If we did not have wood, it would be necessary to invent it in order to have a material to do the many jobs it is called on to perform," the author states.

Although we would still have trouble producing it synthetically, the discovery of the natural product would be hailed with acclaim if it were announced as a new production material.

The Timber Resource Review, compiled by the U. S. Forest Service, has revealed that 34 per cent of our total land area in the United States and coastal Alaska, commercial and noncommercial, is in forest; 36 per cent in pasture and range; 21 per cent in crop land; and about 9 per cent in commercial and urban use.

In the year 2000, lumber consumption is estimated at from 17 to 21 billion cu ft, approximately double our present use. An analysis of this use for 1952, comprising 12.2 billion cu ft, showed that lumber and lumber products represented 53 per cent, pulpwood 22 per cent, fuel wood 16 per cent, veneer and plywood 3 per cent, and miscellaneous uses 6 per cent.

Looking ahead, per-capita consumption of lumber should decrease slowly, whereas in recent years consumption of some products like pulpwood and veneer logs has risen sharply. The average American uses about 80 cu ft of wood per yr, twice as much as a Russian, four times as much as an Englishman, six times as much as a Frenchman.

To balance cutting in the year 2000, it will be necessary to raise the annual timber growth from today's 47 billion board feet to between 80 and 100 billion board feet, or even more.

If we put every acre under good forest management, the author states, we can have the timber we need as the continuous yield of our forests. However, there are $4\frac{1}{2}$ million ownerships represented in the 73 per cent of forest land that is privately controlled, and 86 per cent of the privately owned forest is in tracts of less than 100 acres.

How to get the small owner to grow the kind and quality of timber needed, and how he can combine with other small owners to provide marketable products with greatest potential returns are the crux of the management problem.

Forest research is another important aspect of the problem. Considerable progress has been made in forest genetics—in improving certain species and in selecting and breeding for superior wood properties. Integrated utilization will provide lumber, veneer, plywood, paper, fiberboards and particle boards, molding compounds, and chemical products. It has already reduced woods and mill waste so that about two thirds of the tree is now used.

Diversification of the species base for pulp and paper, development of semichemical and cold-caustic-soda pulping processes have significantly increased yields in that area. Fundamental studies of the chlorinated

phenols as wood preservatives, significant progress in the development of the basic chemistry of wood sugars and their production from wood waste, glued lamination developments, and sandwich construction, improved utilization in the structural-engineering field through the development of structural-timber grades, increased use of mill residues for the production of pulp, and further development of the fiberboard industry are all the outcome of forest-products research.

More study of the basic chemistry of both hardwoods and softwoods is needed, the author concludes. Furfural is in increasing demand; lignin processes are needed to reduce the degradation of that material and to develop fractions with properties that make it valuable. We need to know more about extractives, and means of utilizing bark; and to improve sawing and milling practices.

Better standardization and improvement of product and seasoning are also needed. As yet, we do not have comparability of grades or standard sizes of lumber associated with specific moisture content.

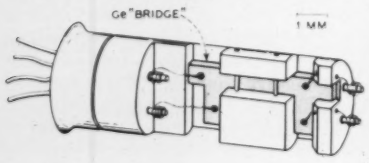
Germanium Resistance Thermometer

A GERMANIUM resistance thermometer having high sensitivity and exceptional stability in the temperature range near absolute zero has been developed by J. E. Kunzler, T. H. Geballe, and G. W. Hull, of Bell Telephone Laboratories. Once calibrated, this thermometer is reproducible to better than a few ten thousandths of a degree at the boiling point of helium, 4.2 K, even after repeated cycling from room temperature. The thermometer should be useful for the accurate measurement of temperatures in outer space or other low-temperature calorimetric work.

The heart of the thermometer is a very small "bridge" about 0.025 × 0.020 × 0.210 in. cut from a single crystal of arsenic-doped germanium. Current and potential leads are attached to the bridge, and it is supported in a strain-free manner in a platinum-glass enclosure containing a small amount of helium gas to aid in thermal conduction. The resistance is determined by measuring the potential drop when a small known current of approximately 10 microamperes is passed through the bridge.

A typical thermometer made at Bell Laboratories had a resistance of about one ohm at room temperature, 14 ohms at 10 K, and 216 ohms at 2 K. Both the temperature coefficient and the actual resistance vary widely with minute changes in the amount of doping, making it possible to fabricate a thermometer having any of a wide range of characteristics. Such a thermometer will retain its calibration despite repeated cycling from 300 K to 1 K.

These resistance thermometers are not available from Bell Telephone Laboratories, but a number of them are being turned over to the Calorimetry Conference for testing. If this Conference finds that they have wide usefulness, efforts will be made to interest a qualified manufacturer in making them commercially available.



Internal construction of the germanium resistance thermometer

Gangsaw on Wheels

A PORTABLE 24 × 26-in. gangsaw mounted on a low-bed semitrailer which can be towed right into the woods for ripping up logs with continuous feed has been built by Gunderson Brothers Engineering Corporation, Portland, Ore. The gangmill, driven by diesel engine through multiple V-belts, places a gross weight of 23,440 lb on the twin rear axles of the less than 8-ft-wide trailer. Both figures come well within highway regulations and the equipment has seen service throughout the western states.

To overcome vibration which is intense even on stationary gangsaws, the crankshaft with drive sheave on one end and damper flywheel on the other was placed unconventionally at the top. The shaft is of unusual composite construction, being of 5-in-diam forged and machined SAE 4140 steel-bar stock. At the center is a crankpin with $9^1/_2$-in. throw. The pin is also of SAE 4140 steel, hardened, chrome-plated, and ground. It is pressed into heavy crank webs which are burned out of $2^5/_8$-in. mild steel plate and which have integral counterweights to balance out centrifugal forces. The crank

This portable 24×26-in. gangsaw can be towed into the woods for milling on location. Width and weight are within highway regulations.

webs in turn are arc-welded to the main shaft, making an assembled unit 6 ft $10^3/_4$ in. over-all and weighing 811 lb.

In the interests of maximum strength and minimum weight, all major elements of the gangsaw are of welded-steel plate and structurals. They include the side frames, frame cap, sash crosshead, and flywheels. The crosshead carries the sash in which multiple saw blades are mounted. Joined to the crankshaft through a heavy connecting rod, it travels in vertical guides on the frame sides and normally has an operating speed of about 300 strokes per min. Saw blades can be positioned to cut slab widths as narrow as 1 in.

Leighton W. Johnson, Mem. ASME, Chief Engineer for Gunderson Brothers Engineering Corporation, received an award for the design in a recent Machine Design Competition sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Machine Abstracts

A METHOD for producing abstracts of scientific and technical articles using an IBM 704 Electronic Data Processing System is being developed by International Business Machines Corporation. The articles are analyzed sentence by sentence by the huge computer. The machine then selects the most significant sentences and reproduces them on an electronic printer. At a glance, an engineer or scientist can determine whether or not the article is of value to him.

In the machine-abstracting technique the article to be treated is first punched out on IBM cards, then transcribed to magnetic tape, in which form it is ready to be fed to the machine. Optical scanning systems are now in the development stage which may eventually eliminate the card stage entirely. Documents will be inserted directly into the machine where they will be "read" in a fraction of a second and will be written at the same time on tape.

As the tape is read, the program, or set of instructions stored in the computer, is activated. The computer is incapable of intellectual comprehension. It can only treat words as physical entities. It determines their significance by measuring the frequency with which they are used individually and the frequency of combinations and couplings.

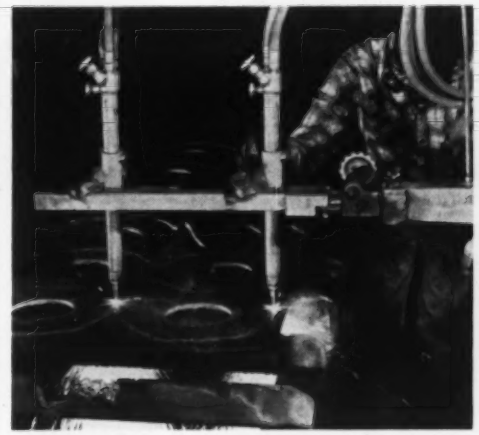
The entire article is scanned and submitted to a statistical analysis of word usage and placement, from which a table of values is made. The machine then analyzes each sentence based on this table and awards a significance factor to it.

Then depending on the degree of these factors, it will select the several highest ranking sentences and print them out.

If the significance is very high, a single sentence might serve as the entire abstract. If, on the other hand, the meaning is strung out in several sentences, the machine will print out all of these.

The advantage of machine abstracts is that the original and only the original statements of authors appear in the abstract and are not subject to misinterpretation by human evaluators.

IBM researchers point out that this is merely a first step in literary abstracting, but enough success has been achieved to warrant further development.



Two brake-rotor profiles, simultaneously cut by torches mounted on a cutting machine. Brake rotors *A*, after shape cutting, and *B*, after drilling.

Here slots $^{1}/_{16}$ in. wide are precision-cut in $^{7}/_{16}$-in-thick steel plate. Brake rotors *C*, after slotting; *D*, after finishing.

Precision Flame Cutting

OXYACETYLENE shape-cutting is now the key to faster production of brake rotors for jet aircraft by Alpha Industries, Logansport, Ind. Not only are the brake rotors shaped by the torches, but flame-cutting is used for producing 18 precision slots in each rotor.

Together with the Linde Company, division of Union Carbide Corporation, Alpha engineers worked up an entirely new production method to replace machine-tool cutting. Rotors, formerly fabricated in six segments, are now produced in one piece, thus increasing service life and simplifying the production cycle for these components of jet aircraft.

Development of the new production method hinged on the ability of an Oxweld CM-15-36 cutting machine and twin C-39 torches to make 18 close-tolerance slots $^{1}/_{16}$ in. wide in the $^{7}/_{16}$-in-thick steel blank. Here's the production sequence worked out by Linde and Alpha engineers:

Two rotor profiles are simultaneously flame-cut by the cutting machine which mounts twin Oxweld C-39 cutting torches side by side on a special 90-deg adapter bracket. The torches are guided by magnetic tracing equipment to insure maximum accuracy along the 18-in. inner and 42-in. outer circumference of the rotor blank.

Each rotor blank is then annealed and 24 holes drilled. The drilled blanks are placed on a rotating positioner and the CM-15-36 machine and C-39 torch team up to handle the precision flame-slotting operation. The cutting torch slices 36 in. of circumferential arc slots and 12 in. of radial slots—a total of 48 in. of exact $^{1}/_{16}$-in. slotting per rotor. Time for slotting: only 11 min.

Following the slotting operation, the rotors are again annealed and then rough ground, broached, countersunk, heat-treated, finish ground, and deburred.

Nuclear Briefs

▶ Consumers SGR Power Plant

THE Atomic Energy Commission has selected the Bechtel Corporation, of San Francisco, Calif., as the architect-engineer for the sodium-graphite nuclear reactor to be constructed at Hallam, Neb., by the Commission under a co-operative arrangement with the Consumers Public Power District of Nebraska.

The nuclear power plant will be operated by Consumers as part of its electrical generating system. The Commission has assigned technical responsibility for the nuclear-reactor facilities to Atomics International, a division of North American Aviation, Inc., of Los Angeles, Calif.

The project, one of those proposed in the AEC's first demonstration-reactor program, will consist of a sodium-graphite reactor feeding steam to conventional turbogenerator equipment. The plant is to be designed to produce 75,000 net electrical kw. Approximately $3^1/_2$ years will be required for the design and construction.

Cost of the reactor portion of the plant will be about $29 million of which Consumers is providing $5,220,000. In addition, Consumers will provide the site at Hallam, Neb., and will be responsible for construction of the turbogenerator portion of the power plant.

▶ Aluminum Alloy for Fuel-Element Cladding

The Argonne National Laboratory of the AEC has developed an aluminum alloy which is expected to help reduce the cost of producing nuclear power.

The experimental alloy, designated X-8001, will be used as a protective jacket (cladding) for fuel elements in the Argonne Low Power Reactor, ALPR, now being built at the National Reactor Testing Station in Idaho by Argonne for the Commission's Army reactors development program.

ALPR is a prototype unit of a portable boiling-water reactor for power generation and space heating in remote areas, such as the Antarctic.

Alloy X-8001, the fuel-element cladding, was developed by adding small amounts of nickel to aluminum 1100, a commercial alloy which contains iron. The addition of nickel made X-8001 much more resistant to corrosion by high-temperature water than commerical aluminums having iron as the primary alloy material.

▶ EBWR Power Level More Than Tripled

The operating power level of the Atomic Energy Commission's Experimental Boiling Water Reactor at the Argonne National Laboratory's main site near Lemont, Ill., has been increased to 61,700 kw of heat—more than three times its original design maximum of 20,000 kw of heat. This was the second time that the reactor's heat power level had been boosted successfully and without hazard (MECHANICAL ENGINEERING, February, 1958, p. 85).

Fermi Reactor Vessel Shipped

THE 36-ft-high 183,100-lb reactor vessel for the Enrico Fermi Atomic Power Plant has completed the 1598-mile journey to the operational site by barge and rail from the Chattanooga (Tenn.) Division of Combustion Engineering, Inc., who were the designers and constructors.

The reactor vessel is the most complex stainless-steel pressure vessel of its size ever built and many of the procedures that went into the vessel had no precedent.

Major closure welds of the lower to the upper reactor vessel and of the upper reactor vessel to the conical transition section required nearly two months on a 7-day week basis, including time for inspection and optical checks.

The reactor vessel is made up of four separate cylindrical vessels welded together to form a single unit assembly. The four major components are a lower 9-ft 6-in-diam reactor vessel, a 14-ft $6^1/_2$-in-diam upper reactor vessel, a conical transition section and plug container, and a transfer-rotor container.

The lower reactor vessel houses the baffling and ther-

Materials Briefs

▶ Dysprosium in Commercial Quantities

DYSPROSIUM METAL, one of the rare earths, is now being produced in lump and ingot form by Nuclear Corporation of America, Burbank, Calif. Gram-to-pound lots of 98 to 99 per cent purity are available.

The metal's neutron cross section of 1100 barns, corrosion resistance, workability, weldability, and relatively high melting point of 1400 C suggest use in nuclear-reactor control rods.

In electronics, dysprosium's paramagnetic properties qualify it as a component of ferrites, or "garnets," a group of materials with applications in microwave equipment. Related to semiconductors, these materials are used in the new magnetic amplifiers known as masers.

▶ Cold Extrusion of Hollow Titanium

The first successful cold extrusion of hollow-titanium shapes—a major step in the development of economic methods for producing hollow aircraft parts—has been brought to the threshold of commercial application by Battelle Memorial Institute under an Air Materiel Command, Manufacturing Methods Branch contract.

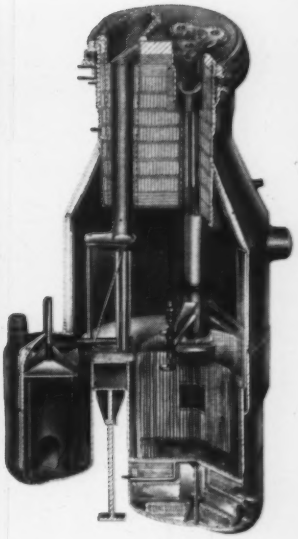
A production-size 700-ton hydraulic press was used for forward and backward extrusion of unalloyed titanium shapes with 30 per cent increases in tensile strength, and surface finishes of 30 to 60 microinches, equivalent to a smooth turned finish.

In forward extrusion studies, $1^1/_2$-in-OD $^7/_8$-in-ID cup-shaped billets were cold-extruded into cylinders with wall thicknesses down to 0.15 in. Backward cold extrusion of $1^1/_2$-in-diam slugs of unalloyed titanium produced cups up to 3 in. long with wall thickness down to 0.22 in., a 50 per cent reduction.

▶ USS T-1 Steel Strength Upped

New guaranteed-strength minimums for USS T-1 Steel have been assigned by U. S. Steel Corporation after continuous tests on production lots. The minimum yield strength of T-1 has been increased from 90,000 to 100,000 psi and minimum tensile strength has been increased from 105,000 to 115,000 psi. The published tensile-strength maximum of 135,000 psi remains unchanged.

The reactor vessel for the Enrico Fermi Atomic Power Plant shown in cross section, *right;* and *at left,* as it is turned from vertical position to the horizontal



mal shielding, distributes the inlet coolant flow through the nuclear fuel, the plutonium breeder blanket, the control rods, and the shield. It contains support plates which support and locate 673 eight-ft-long, $2^1/_2$-in-sq tubes containing the nuclear fuel, breeder blanket, and nuclear control and safety rods.

The upper reactor vessel houses the fuel-handling device, the hold-down plate, and the eight safety rods. The main sodium coolant discharge is in this section.

The conical transition section and plug container houses and supports the rotating plug, which in turn houses and supports the fuel handling device, the hold-down drive mechanism, and control safety rod drive.

The transfer-rotor container houses the transfer rotor which provides for lateral transfer of fuel and blanket subassemblies to a position where they can be removed from the reactor vessel. It also provides the temporary decay storage for irradiated subassemblies immediately after removal from the reactor.

The accuracies required in the assembly and alignment of the APDA vessel would have been difficult, or impossible, to achieve without optical tooling methods and equipment. A tolerance of $\pm 1/16$ in. in a distance of $96^1/_2$ in. on one dimension proved to be within $1/32$ in., a deviation of only one part in 3088. This was accomplished while maintaining a parallelism of surfaces approximately 10 ft in diam.

A series of parallel horizontal planes were established by the use of a tilting level equipped with an optical micrometer and an alignment telescope with a stride level. The intermediate section of the vessel was first set up on legs so that a previously established plane at elevation 0 ft, 0 in. was horizontal. After positioning the lower vessel in relation to center lines and an internal surface, the upper vessel was positioned and flange leveled.

Following installation of the reactor vessel and associated equipment at the Fermi site, 30 miles south of Detroit, Mich., Atomic Power Development Associates will mechanically operate the reactor, with conventional rather than nuclear fuel, as a test facility for about one year, beginning in February, 1959. During this time, full-scale reactor components will be tested under non-nuclear operating conditions. Nuclear fuels will not be used until the entire installation has been thoroughly tested and an operating permit issued by the AEC.

The Enrico Fermi Atomic Power Plant is expected to be ready for initial nuclear operation in 1960. After several months of initial nuclear operation, steam produced will permit the design-capacity generation of 100,000 electrical kw. Later, the reactor's steam output is expected to be capable of operating at its full capacity of 150,000 kw. See MECHANICAL ENGINEERING, March, 1957, pp. 240–242, for a fuller description.

▶ Chromalloy-Treated Molybdenum

Molybdenum can be utilized at working temperatures in excess of 2000 F, as a result of a new surface-alloying technique by Chromalloy Corporation, White Plains, N. Y. Until now it has been impossible to take advantage of molybdenum's outstanding high-temperature strength because at high temperatures a volatile oxide forms leading to rapid erosion and eventual deterioration.

Treatment by the new Chromalloy W-2 process, like the firm's standard Chromalloy process, involves a diffusion of chromium into the surface. This provides molybdenum with a high degree of oxidation resistance, making it ideal for such applications as gas-turbine blades, ramjet flame holders, turbine wheels, gas-generator assemblies, thermocouple-protection tubes, nuclear-reactor rods, heat-exchanger tubes, and missile combustion chambers.

The surface produced by the Chromalloy W-2 process forms an intimate metallurgical bond with the base metal, a uniform depth on all exposed base-metal surfaces, and penetrates all cracks, pores, and recesses. It is easily controlled and reproduced.

▶ O-Ring Compounds

Several new compounds have been developed by Precision Rubber Products Corporation, Dayton, Ohio, for specialized applications—particularly O-rings. Compound 7587 is for service in the new high-temperature hydraulic fluids. The compound has the proper volume-swell requirements, does not crystallize, and operates satisfactorily at temperatures from −65 F to +400 F.

A low-compression-set Butyl, compound 9257, has a compression half that of standard Butyl compounds and shows excellent resistance to deterioration by air at 250 F. After 70 hr at 212 F, compression-set values by ASTM Method B were established at only 44 per cent. After testing for 70 hr at 250 F in air, physical changes were almost negligible. Tensile and modulus losses were −3 and −6 per cent, respectively. Elongation and hardness were unchanged.

Compound 18007 is recommended for testing and use in all rocket and missile applications which use red fuming nitric acid and for other acid applications where standard synthetic materials have failed to give satisfactory performance.

PHOTO BRIEFS

1 **Fuel Cell.** A demonstration model of an improved fuel cell lights a bank of sealed-beam headlights. The cell introduced by the National Carbon Company division of Union Carbide Corporation (Mechanical Engineering, November, 1957, pp. 1050-1051) uses electrodes of specially treated porous carbon in nested concentric cylinders, and operates on oxygen from the air and hydrogen gas.

2 **Sniffer.** Compressed air with trichlorethylene fumes is pumped into the integral wing fuel tanks by the Chance Vought F8U-1 Crusader to test for leaks. Any escaping fumes are detected by the sniffer which emits an audible signal.

3 **Smooth Weld Inside.** Arcos Corporation's consumable-weld-insert technique developed for butt welding pipe was successfully used by Newport News Shipbuilding & Drydock Company to maintain a smooth interior, although all welding was done from the outside.

4 **Missile Dummy.** A redwood dummy is one of the launching test techniques developed by Westinghouse scientists for the U. S. Navy's Polaris missile. Internal instrumentation records speeds, temperatures, stresses, and other technical data.

5 **Expansion Joints.** Badger Manufacturing Company, Cambridge, Mass., working closely with Catalytic Construction Company and Firestone Tire and Rubber Company engineers, solved a number of unusual problems by the use of Service Rated (S-R) expansion joints. The Orange, Texas, Firestone plant will produce 40,000 tons per year of butadiene from butane by the Houdry catalytic dehydrogenation process. Hot hydrocarbon lines varying from 40 to 48 in. in diam lead to the quench tower, and in addition to flexing must handle pressures from near vacuum to 2 psia at 1000 to 1100 F.

6 **Largest Solar Furnace.** Model of the world's largest solar furnace, soon to be installed near Cloudcroft, N. Mex. The 151-ft-wide flat-mirror heliostat will capture and reflect the sun's rays to the 108-ft-diam parabolic focusing mirror. A 5-in-diam 7000-C "hot spot" will be created for materials testing. The officials of J. W. Fecker, Inc., of Pittsburgh, Pa., the division of American Optical Company which designed the optics and servo control equipment shown, **left to right,** are: Ralph Wight, chief physicist; Joseph Kalla, president; and Paul Kaestner, Mem. ASME, chief engineer.

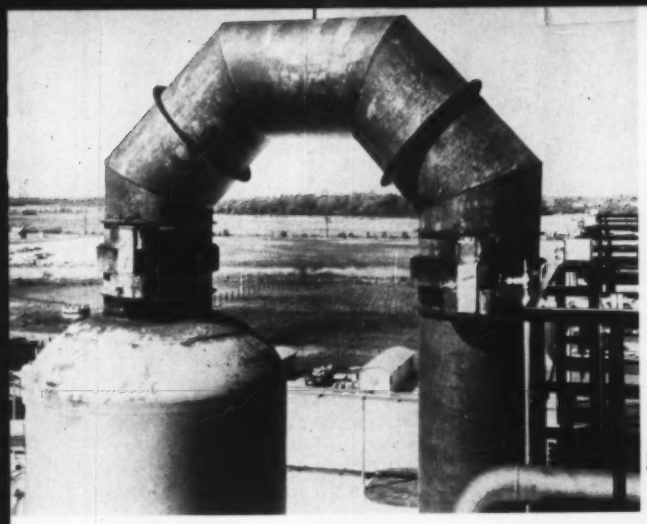
7 **Water-Resistant Insulation.** Silco-Flex insulation developed by Allis-Chalmers for their Super-Seal motor line can be completely immersed in water. Here a 500-hp motor stator fully wound with 4000-volt Silco-Flex insulation takes 18,000 volts without breakdown.

8 **Clear Plastic Walls.** A workman at the Brussels Fair adjusts plastic H-channel on a clear wall made of Bakelite rigid vinyl sheet. The 85-ft-high walls of the $5-million U. S. Pavilion are the first such used on a major building. Each 2 × 5-ft, 0.125-in-thick panel weighs about 12 lb.

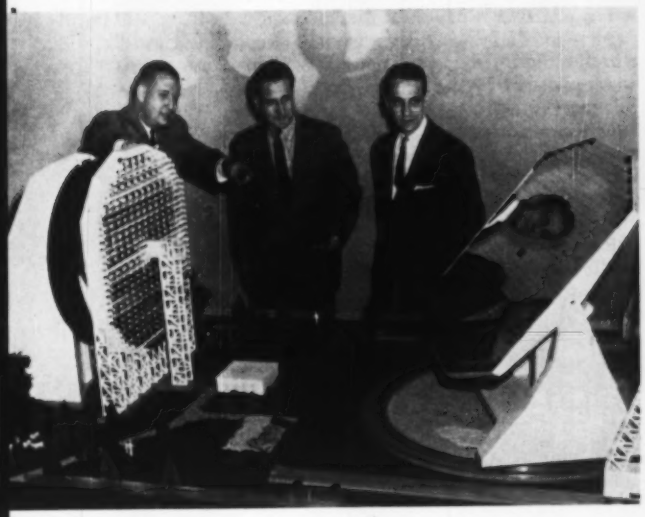
1

2

3



5



6

7

8

4

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

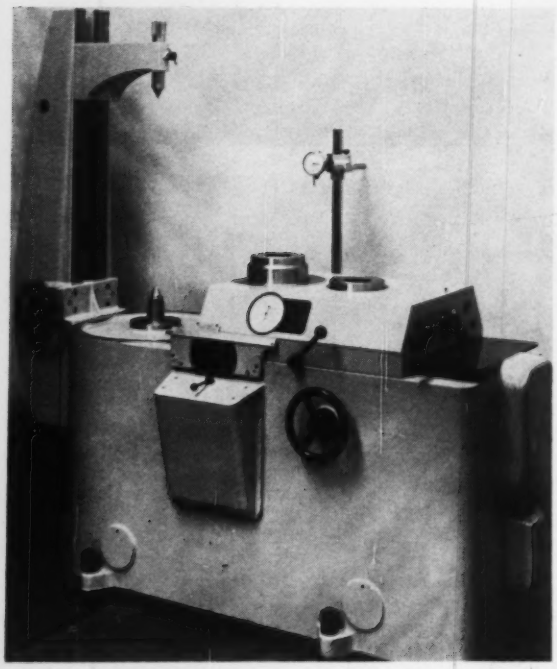
EUROPEAN SURVEY

Rolling Tester for Gears

IN THE "European Survey," (MECHANICAL ENGINEERING, August, 1955, page 697), descriptions and illustrations were given of two sizes of a new type of rolling gear tester developed by J. Goulder & Sons, Ltd., Kirkheaton, Huddersfield, England, the larger of which would accommodate gears weighing up to 25 lb each.

The firm has now produced a considerably bigger model, the No. 4, with a capacity of 32 in. between centers, corresponding to a maximum gear size of about 4-ft diam. Attachments are provided to take shaft gears up to 32 in. long and 20 in. diam, as well as for worms and worm wheels, bevel gears, and internal gears. A power-operated rotary table can be supplied if desired.

Rolling gear tester for gears up to four feet in diameter was developed by J. Goulder & Sons, Ltd., Kirkheaton, Huddersfield, England.



The variations in center distance are read from a dial gage, 4-in. diam, located in front of the floating saddle, which is mounted on precision balls. The nominal center distance is set by means of a vernier and scale; and an electrical recording apparatus can be fitted, giving magnifications of between 100 and 5000, to provide permanent records of the gears checked.

The saddles may be driven by hand or power in any direction and are controlled either from a handwheel in front of the stand or by a lever on the control panel. The sensitive saddle may be lifted off its tracks by a cam and lever to prevent damage when loading heavy gears, and is fed forward against the gear under test (or backward, in the case of internal gears) by a spring, adjustable to any pressure up to 20 lb. The slide ways are completely covered by a rigid plate. The frame is a Meehanite casting, supported on three feet for setting, but fitted with two additional feet to insure final stability. All steel surfaces are either nitrided or nickel-hardened. Lifting holes are provided in the main casting for ease of handling, as the instrument weighs some 2000 lb.

The Swiss Industries Fair

THE 42nd Swiss Industries Fair, which closed at Basle on April 22 after the usual run of 11 days, is reported to have been visited by about 760,000 persons of whom, it is estimated, about 30,000 came from other countries, though only 12,936 of these "clocked in" at the reception center. The breakdown of this figure is of some interest, for it shows that, while only 798 of the 12,936 came from countries outside of Europe, 241 of them were from the United States, the runner-up being Brazil with 51. Canada sent only 21. Of the 12,138 from European countries, Western Germany provided considerably more than half (7152). The only other four-figure contingent, 2544, was from France. East Germany sent 3. Last year the main emphasis, in the machinery halls, was on textile machinery; this year it was on machine tools, principally of metal-removing types, electrotechnical equipment, and woodworking machines. These last, however, differ little from year to year; for some reason, there seems to be more scope for change in metalworking, though fundamentally (apart from such comparative novelties as welding and spark erosion) the principles are the same.

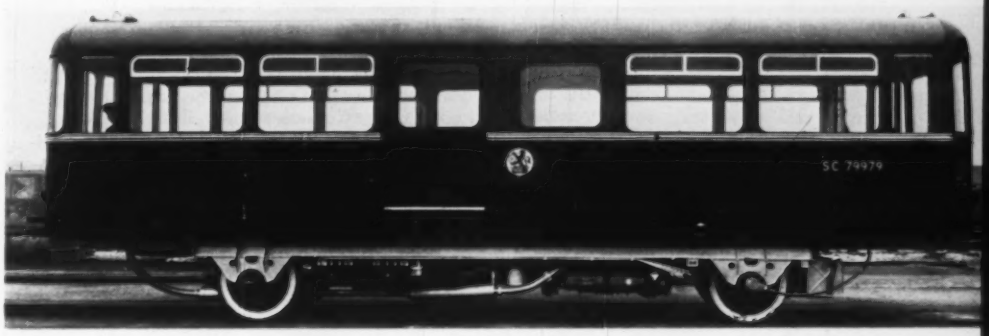
Correspondence with Mr. Petree should be addressed to 39 Mayfield Road, Sutton, Surrey, England.

Railway Development in France

When France was liberated in 1944, the Société Nationale des Chemins de fer Français (S.N.C.F.) had lost 82 per cent of its motive power, 60 per cent of its passenger cars, 64 per cent of its freight rolling stock, and many thousands of its personnel; and 70 tunnels, 77 roundhouses, and 2600 bridges had been more or less destroyed. Wholesale reconstruction was imperative, therefore, and the field for technical improvement was immense. How well the opportunity was taken is obvious to any traveler on the French railways today, which in various ways are in advance of anything to be found elsewhere in Europe; for example, every day mainline electric trains cover 40,000 kilometers (about the circumference of the Earth at the Equator) at speeds of 62 mph or better. A notable technical feature is the steady increase in power/weight ratio of the electric locomotives. The 2D2 class, which hauled 850 tons at 87 mph on the level, weighed 148 metric tons; the CC 7000 class, of which some 60 are now in service, have as good a performance, but weigh only 105 tons. They have a continuous output of 4700 hp. One of them shares the world's rail speed record of 206 mph jointly with another new type, the BB 9000 class, which weighs only 85 tons. Diesel traction is extending rapidly on the lines not yet electrified, for the French policy (like the British) is to abolish steam traction entirely; so far, the biggest are the 2000-hp diesel-electric locomotives, weighing 120 tons, used on the northern section of the outer circle line around Paris. A new design of the BB type—on order, but not yet in service—will have a single diesel engine of 1400 hp, running at 1500 rpm. They will weigh 72 tons and will have a maximum speed of about 65 mph, and are intended to be coupled together and operated as multiple units for heavy loads.

Experiments are in hand, according to M. Pierre Weil, of S.N.C.F., with the remote control of trains—not merely by radio telephony between the train dispatcher and the engine driver, though this has been employed with success over distances up to 60 miles, but by actual instrumental control of the locomotive itself. It was tried experimentally with an express train in 1955, but has now been extended to the shunting of cars in a marshalling yard, where long trains have been sorted quite successfully.

Current research is directed to developing means to detect obstacles in the path of a train, and to couple an engine to its train automatically. The net result of the reconstruction program so far is that, compared with 1938, the French Railways are carrying nearly 50 per cent more passengers and over 100 per cent more freight with a staff of only 365,000 instead of 514,000, with a smaller amount of rolling stock and energy consumption.



Lightweight diesel railcar is designed to operate in rural areas. It weighs only 11 tons, can seat 46 passengers, and is capable of speeds up to 55 mph.

Lightweight Diesel Railcar

The French Railways have shown what can be done to improve and increase mainline traffic, but all over Europe railroad managements find themselves up against a problem in trying to operate small branch lines remuneratively. Hundreds of miles of such lines have been closed down in the British Isles alone, and even the little *vicinaux*, once so common along roadsides in Belgium and France, are tending to disappear. British Railways are getting good results with two-car and four-car diesel trainsets in many districts where steam services did not pay, but there are lines where even these diesel sets would be uneconomic. To deal with them, British Railways are trying out a new type of diesel railcar, seating 46 passengers, weighing about 11 tons, and powered by a single six-cylinder engine of 150 hp, arranged horizontally under the floor and giving a maximum speed of about 55 mph. The drive is through a fluid flywheel and thence through a free-wheel unit to a four-speed epicyclic gearbox; and from this by shaft, fitted with universal joints, to a gear mounted centrally on one of the axles. The torque reaction is taken by an arm attached to the underframe. The reversing gear is in the same box as the final drive. The engine throttle, change-speed gears, and reverse gear are all operated through electropneumatic valves. The car body is a light steel shell, fabricated by welding and with exterior panels and roof of aluminum sheet. The doors are fitted approximately at mid-length and are operated electropneumatically by the driver. Driving positions, with complete sets of controls, are provided at each end of the car.

The vehicles have been designed to the requirements of the British Transport Commission by A. C. Cars, Ltd., of Thames Ditton, Surrey, England. The 22 on order have been allocated to rural areas in three English regions and also in Scotland.

Substance in Brief of Papers Presented at ASME Meetings

M. ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST

Gas Turbine Power

Small-Scale Burner Tests to Investigate Oil-Ash Corrosion.....58—GTP-19

By R. C. Amero, A. G. Rocchini, C. E. Trautman, Gulf Research & Development Company, Harmarville, Pa. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

About 125 small-scale burner tests were run to investigate high-temperature corrosion of alloy steel by ash from residual fuel oils. In most of these tests a specimen of AISI-310 stainless steel (25–20 Cr-Ni alloy) was exposed for 100 hours at 1450 F to the combustion gases of No. 6 or Burner Fuel Oil-Navy Special containing 150–200 ppm vanadium, without or with experimental additives. The small-scale burners and a full-scale ten-inch combustor (from a Westinghouse gas turbine) operated at substantially atmospheric pressure showed very good agreement with respect to corrosion and deposits formed in 27 comparative tests.

The following results were obtained on the small-scale burners:

1 Many of the additives substantially reduced corrosion of the AISI-310 stainless steel. The most effective additives, including some not previously reported in the literature on oil-ash corrosion, contained one or more of the following elements: Mg, Mn, K, Na, rare earths, Sr, Th, P, W, Ni, Sn, and Zn.

2 Synthetic sea water, as well as other materials containing sodium and/or potassium, reduced the corrosive action of vanadium-containing ash at 1450 F and enhanced the effectiveness of other corrosion-inhibiting additives.

3 Oil-soluble compounds of effective elements were more expensive but not necessarily more effective than aqueous solutions or insoluble powders. Micronized talc, potassium permanganate, and magnesium oxide substantially reduced corrosion in small-scale burner tests at an estimated materials cost of one cent, 11 cents, and 0.8 cent per barrel of fuel, respectively.

The Effect of Treated High-Vanadium Fuel on Gas-Turbine Load, Efficiency, and Life...58—GTP-17

By B. O. Buckland, Mem. ASME, General Electric Company, Schenectady, N. Y. 1958 ASME Gas Turbine Power Conference (multilithographed; available to Jan. 1, 1959).

Tests were run on four intercooled regenerative high-temperature gas turbines of like design to measure the effect of burning several different residual fuels. Some of the tests were made with the help and co-operation of the Central Vermont Public Service Corporation on two of their units at Rutland, Vt. Other tests were made at Bangor, Me., with the help and co-operation of The Esso Research and Engineering Company, and the Bangor Hydroelectric Company, on the two units in the Graham Station. The results of the tests can be summarized as follows:

1 After a few hundred hours of intermittent operation, the first-stage nozzle area reaches a steady-state condition wherein it oscillates between zero and a maximum of about 8 per cent reduction in area due to oil ash. The maximum reduction varies from 4 to 8 per cent, depending on the fuel.

2 With continuous operation the first-stage nozzle area does not reach a steady-state value in 100 hr, but plugs more or less continuously at rates varying from 5 to 24 per cent per hundred hours, depending on the fuel. The load decreases also at rates varying from one to 20 per cent in the same period.

3 Increasing the magnesium content of the fuel with respect to its vanadium content increases the deposition rate, but increasing the aluminum with respect to the vanadium content has the opposite effect.

4 Substantial temperature changes due to load variations and changes of firing temperature have little or no effect on dislodging the ash, but shutdowns in excess of two hours' duration cause recoveries of over 70 per cent in the area and over 50 per cent in the load.

5 Introducing about 15 lb of spent refinery catalyst into the low-pressure compressor inlet results in more than 40 per cent recovery in the nozzle area and about the same recovery in the load. This cleaning operation, followed by a shutdown, results in practically complete recovery in both load and area during subsequent operation.

A test was run for 2400 hr with a single residual fuel containing about 360 ppm of vanadium following 2700-hr operation on distillate fuel. Comparisons of the gas-path parts with those of two other units of the same design, one using a residual oil having 80 ppm of vanadium and the other using natural gas, led to the following conclusions:

1 The life of the gas-path parts is no different whether a high-vanadium or a low-vanadium residual fuel is used;

2 The corrosion of the nozzles and buckets is not much greater with treated residual oil than with natural gas.

Present State and Future Outlook of the Free Piston Engine..58—GTP-9

By R. Huber, Directeur Technique de la Société D'Etudes Mécaniques et Energétiques, Rueil-Malmaison, France. 1958 ASME Gas Turbine Power Conference paper (in type; to be published in *Trans. ASME;* available to Jan. 1, 1959).

The first part of the paper gives a short description of the gasifier, type GS-34, with diagrams showing the main operational factors versus gas pressure and stroke length. The present state of its application to ships, stationary plants, and locomotives is reviewed briefly. Details are given when running with a reduced number of gasifiers in service in a stationary power plant of 6000 kw (Cherbourg). In the second part, the trend of future development is examined, especially with regard to an increase in power output per gasifier. The possibilities and limits of supercharging and afterburning are studied, as well as twinning of the gas-generators and increase of their size. The general relationship for simi-

lar engines but of different sizes is given. A gasifier with a 20-in. diesel bore is studied. Such an engine, supercharged, twinned, and with after-burning would produce 8000 to 10,000 hp on the turbine shaft per unit.

Operating Experience With 750/1000-Kw Gas Turbines. 58—GTP-4

By G. B. R. Feilden, Ruston and Hornsby, Ltd., Lincoln, England; and T. P. Latimer, Turbo-Products Division, Clark Brothers Company, Olean, N. Y. 1958 ASME Gas Turbine Conference paper (multilithographed; available to Jan. 1, 1959).

After giving a brief survey of some of the salient design features of the Mark TA 750/1000-kw gas turbine, an account is given of some of the different categories of application found for this machine throughout the world, indicating the economic factors which have led to the selection of gas turbines rather than alternative types of prime mover.

The main portion of the paper deals with the operating experience which has been obtained on turbines burning natural gas, distillate, and crude-oil fuels.

The operation of 29 Mark TA turbines which are now in service has been noteworthy for its complete freedom from blade breakages or other major failures. The few service troubles which have arisen, in nearly all cases, have been concerned with the operation of auxiliary equipment, and further development work is actively in progress on these items, in conjunction with the specialist manufacturers concerned, where necessary. The paper ends with an assessment of future trends in the application of medium-power gas turbines. Attention is given to the integration of the turbine with packaged assisted circulation boilers in order to provide compactness and flexibility of output.

Economic Considerations in Applying Gas Turbines to Electric Utility and Industrial Applications..... .....58—GTP-20

By C. R. Dygert, General Electric Company, Schenectady, N. Y. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

Data have been collected which aid in evaluating various gas-turbine cycles. This paper presents estimating cost data which can be used for preliminary evaluations. It discusses factors, unique with the gas turbine, which should be considered.

The type and number of units installed, the size of the installation, its location, the type of fuel fired, and the actual application, all have an important bearing on the cost of a gas-turbine installation. Structures and services, electrical and starting equipment, multiple-unit stations, outdoor installation, fuels, duct systems, one-shaft versus two-shaft units, all must be considered in such an evaluation.

Factors affecting output and efficiency include compressor inlet temperature, atmospheric pressure, and inlet and exhaust duct-system pressure drops all of which have a pronounced effect on gas-turbine performance. Criteria for a detailed economic analysis are presented.

A Model W-121 Gas Turbine for Power Generation and Mechanical Drive.....58—GTP-1

By R. E. Strong, Westinghouse Electric Corporation, Philadelphia, Pa. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

The Model W-121 is a single-shaft gas turbine constructed with a 14-stage axial-flow turbine. Combustion takes place in six combustors housed around the axis of the machine between the compressor and the turbine.

This paper presents the basic design of a Model W-121 gas turbine with a nominal rating of 12,000 hp and 8500 kw for mechanical and electrical drive applications.

A general description of the essential features of construction and design of the basic components is given. Emphasis is placed on compressor, combustion-system, and turbine design.

The Model W-121 is the newest in a line of turbines that have demonstrated reliability in diversified applications in such fields as electric-power generation, natural-gas transmission, oil-field repressurization, and so on.

The Use of Adjustable-Stator Blades to Reduce the Idle Fuel Flow of a Simple-Cycle, Single-Shaft Gas Turbine.....58—GTP-5

By C. Howard, Jr., Mem. ASME, and R. L. Hendrickson, Mem. ASME, General Electric Company, Schenectady, N. Y. 1958 ASME Gas Turbine Power Conference paper (in type; to be published in *Trans. ASME;* available to Jan. 1, 1959).

Factors affecting idle fuel flow in a simple-cycle, single-shaft, gas-turbine power plant are discussed. Test experience in the use of a compressor with adjustable-stator geometry to reduce idle fuel flow is also given. Adjustable inlet guide vanes and five adjustable-stator rows were included in a special forward compressor casing used for the tests.

The principal factors affecting idle fuel flow were shown to be compressor air flow and compressor and turbine-component efficiencies. Rotational speed is a significant variable. Compressor pressure ratio is not an important factor.

The minimum idle fuel flow of a basic gas-turbine plant with the standard (fixed-geometry) compressor was found to be 29 per cent of full-load flow at 55 per cent speed. A more conventional idling point is 80 per cent speed where the fuel flow was 38 per cent. By use of an appropriate adjustable-stator geometry, these values were reduced by 17 and 8 per cent, respectively. However, use of the adjustable-stator casing introduced a penalty on performance with the design blade configuration which amounted to 1 per cent in fuel under load.

The results of several additional test investigations with the adjustable-stator casing also were described.

Valveless Gas-Turbine Combustors With Pressure Gain....58—GTP-11

By C. D. Porter, Naval Research Laboratory, Chesapeake Beach, Md. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

A simple, single-tube valveless resonant combustor has an enlarged combustion chamber with a long connecting tube which serves as tailpipe and a smaller shorter tube which serves as an inlet.

A valveless combustor has been developed which has been tested at one to three atmospheres of pressure. It discharged combustion products at practical turbine-inlet temperatures and at a total pressure above that of the inlet. Developmental problems encountered and results are discussed.

The smooth combustor cycle, a phased system of combustor tubes and pulsation traps, achieves steady flow at the inlet and outlet of the combustor system to preserve the high efficiency of today's turbines and compressors. The combustor will soon be tested on a gas-turbine compressor to verify efficiency gain estimates.

The Comprex—A New Concept of Diesel Supercharging..58—GTP-16

By Max Berchtold, Mem. ASME, and F. J. Gardiner, I-T-E Circuit Breaker Company, Philadelphia, Pa. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

The Comprex—a new concept of diesel supercharging—compresses air by direct transmission of energy from an expanding gas utilizing compression and expansion waves. The Comprex has one rotating element in which both compression and expansion take place. The name Comprex is a contraction of Compression-Expander.

Although the phenomena of nonsteady flow have been studied extensively in connection with explosions, diesel-fuel injec-

tion, railway air brakes, water hammer, safety equipment in hydraulic power stations, and so on; the use of these effects in gases is relatively new. This paper deals with the Comprex as applied to supercharging of internal-combustion engines. It explains the principle of operation, describes the design, and discusses the particular operational characteristics as a supercharger for a four-cycle diesel engine. It should be remembered that this is only one of many applications of a broad and unexploited field.

Nonsteady Aerodynamics of the Comprex Supercharger.....58—GTP-15

By H. U. Burri, I-T-E Circuit Breaker Company, Philadelphia, Pa. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

In contrast to standard gas-turbine machinery, energy exchange from one gas to another is accomplished in the Comprex supercharger primarily by the utilization of nonsteady-flow phenomena; i.e., at one particular geometrical location within the rotor the state of the fluid will vary with time.

A brief outline is given of the method of characteristics for the analysis of one-dimensional nonsteady flow. Two typical types of experiments are discussed which indicate the degree of accuracy possible if this method is applied to machinery like the Comprex supercharger. As an example, a typical analysis is presented for one particular engine-performance point. It is possible to duplicate engine test results with acceptable accuracy.

Rearrangement of the Temperature Field in Flow Around a Bend.....58—GTP-2

By E. R. G. Eckert, Mem. ASME, and T. F. Irvine, Jr., University of Minnesota, Minneapolis, Minn. 1958 ASME Gas Turbine Power Conference paper (in type; to be published in *Trans. ASME;* available to Jan. 1, 1959).

Measurements of the temperature and velocity field are reported for a specific duct geometry which bends the flow by 90 deg and simultaneously accelerates it to an average exit velocity which is twice the inlet velocity. The measurements demonstrate that the temperature field existing in a cross section upstream of the bend is considerably rearranged by the action of the secondary flow. The temperature field also influences the velocity field as observed in the exit cross section. A simple calculation method which allows a prediction of these effects in the core of the flow field is presented and good agreement to the results of the measurements is found. The importance of this flow rearrangement to various engineering applications, especially to the design of gas turbines, is discussed.

The Performance and Reliability of Aero-Gas-Turbine Combustion Chambers.....58—GTP-13

By J. S. Clark, Joseph Lucas Ltd., and H. E. Lardge, Lucas Laboratories, Burnley, England. 1958 ASME Gas Turbine Power Conference paper (in type; to be published in *Trans. ASME;* available to Jan. 1, 1959).

Many papers have been published dealing with combustion in gas-turbine combustion chambers. This paper presents some results on the specialized strength of materials problems and some data relating to durability in actual service.

It first specifies performance requirements. Consideration is given to the range of steady and unsteady operating conditions. The influence of combustion intensity on metal temperature is discussed. Radiation and convection of heat from the primary zone, film cooling, metal temperature variations, and the effects of stresses are outlined.

In considering mechanical reliability, evaluation of materials, evaluation of design by laboratory tests, the influence of manufacture on life, and design changes arising from engine tests, are noted.

Design Analysis of the General Electric T-58 Engine...58—GTP-21

By F. W. Heglund, Assoc. Mem. ASME, General Electric Company, Lynn, Mass. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

The T-58 engine is a lightweight, compact 1050-hp, shaft-powered gas turbine designed by General Electric primarily for helicopters.

The T-58 has an over-all length of 55 in., maximum flange diam of 15 in. and the weight, without reduction gear, is 267 lb.

There are two models, the T-58-GE-2 and the T-58-GE-6. The first of these has completed the official 150-hr model test and is in prototype production; the T-58-GE-6 is scheduled toc omplete the military model test this year, with production commencing in early 1959.

The T-58 engine is a straight-through flow machine of free-turbine design; i.e., it has two independent systems. One is the gas generator and the other, which provides useful power, is called the free or power turbine.

The gas generator consists of the compressor, combustion system, and a two-stage turbine for driving the compressor. The rotor system of the gas generator is a three-bearing system with the center bearing carrying the rotor thrust.

The second system, the power turbine, is a two-bearing, single-stage turbine which drives the rear. There is no mechanical connection between the two rotors.

Each of their assemblies is described in detail in the paper.

The T-58 has accumulated more than 7000 hr of running, including 1120 hr driving helicopter rotor systems.

Results of these tests show that the T-58 design objectives combining high performance, lightweight, ruggedness, and serviceability are achieved.

Accelerated Life Tests of a Pair of Naval Gas Turbines....58—GTP-7

By J. S. Pasman, Assoc. Mem. ASME, and S. E. Fisher, U. S. Naval Engineering Experiment Station, Annapolis, Md.; and C. L. Miller, Bureau of Ships, Department of the Navy, Washington, D. C. 1958 ASME Gas Turbine Conference paper (multilithographed; available to Jan. 1, 1959).

In June, 1955, the Bureau of Ships authorized the U. S. Naval Engineering Experiment Station in Annapolis, Md., to conduct an accelerated life test of a generator set driven by a pair of small, open-cycle gas-turbine engines. The test was originally planned as a 1000-hr test based on the design life of the turbines.

This paper presents the results of a 2500-hr evaluation test performed at the U. S. Naval Engineering Experiment Station under the auspices of the Bureau of Ships. Test procedures, results, and conclusions are presented. The primary purpose of this test was to evaluate a compressor-turbine wheel with blades heavier than were in Fleet service at the time of test. This and other improvements have resulted in a forced down time of 0.6 per cent over a thousand-hour period, and have shown justification for extension of the present 500-hr overhaul period to 1000 hr.

Slipper Bearings and Vibration Control in Small Gas Turbines.....58—GTP-6

By H. C. Hill, Boeing Airplane Company, Seattle, Wash. 1958 ASME Gas Turbine Power Conference paper (in type; to be published in *Trans. ASME;* available to Jan. 1, 1959).

The high rotor speeds of small gas turbines and other small turbine machinery have brought new bearing and vibration problems. Short and unpredictable bearing life, together with destructive high-frequency vibrations have been encountered, as rotor-tip speeds have been pushed upward to reduce size and weight, and to improve thermal efficiencies.

Both difficulties have been found to be associated with rotor-bearing runout and rotor-balance errors, difficult, if not impossible, to eliminate with conventional balancing methods and conventional "antifriction" bearings.

This paper describes several new principles of bearing design which have proved effective in improving the reliability and smoothness of small gas turbines. The importance of radial clearance in all the rotor bearings, including the thrust bearing, has been established.

A self-balancing action, or automatic compensation of balance errors has been obtained with increased running clearances in the bearings. The new bearings designed to accomplish this have virtually eliminated radial-bearing loads and the vibrations they cause.

The new bearings are modified forms of tilting-slipper, radial-journal, and axial-thrust bearings. The key development was the tilting-slipper thrust bearing which not only provided the required radial freedom, but also made possible higher speeds at higher thrust loads.

One of the unique features considered important for performance and low production costs is that the slippers float in their retainers instead of having fixed pivots.

The Control of a Marine Gas Turbine.....58—GTP-10

By F. H. Van Nest, General Electric Company, Schenectady, N. Y. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

The *GTS John Sergeant* was the first large ship to be propelled solely by a gas turbine and a controllable and reversible-pitch propeller. A large amount of data has been published on the design and performance of the ship; this paper, however, deals solely with the engineering problems involved in adapting the gas turbine to marine service.

Over a year's operating experience with the *GTS John Sergeant* has proved beyond a doubt that a two-shaft gas turbine with a variable-area load-turbine nozzle is well suited to marine service. When properly engineered, its reliability is as good or better than any other type of marine engine. The combination of the gas turbine and reversible and controllable-pitch propeller has made the *John Sergeant* more maneuverable than any other ship of its size in existence.

The gas turbine can successfully burn residual fuel if bought, or as in the case of the *John Sergeant*, if treated aboard ship, to meet a specification which limits sodium and vanadium content and/or introduces an additive to nullify their corrosive effect.

The low specific fuel consumption which the *John Sergeant* has demonstrated makes it more than competitive with the best steamships in its power range. In addition, the substantial reduction in engine-room personnel which is possible contributes materially to low annual operating cost.

In the larger power ranges, a gas-turbine cycle of this type may not be competitive with the best steam-turbine plants on a specific fuel consumption basis alone, but the reduction in personnel cost should still make it highly competitive on an annual operating cost basis.

All of the experience to date on the *John Sergeant* indicates that the gas turbine should become a major factor in marine propulsion work as soon as the desired sizes are available.

Operating Experience of General Electric Turbines.....58—GTP-18

By H. D. McLean, General Electric Company, Schenectady, N. Y. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

A review is made of all General Electric Company Gas Turbines installed and operated previous to January 1, 1958. The gas turbines are reviewed with respect to application, fuels burned, fired hours, and miscellaneous features. Each different basic design is briefly described, with date of first operation and total number installed given. Gas turbine failures that have occurred in operation are discussed.

Availability, reliability, and use factors are given. A brief review of published articles by gas turbine owners and operators is made. Problems that have occurred in eight and one-half years of operation are discussed, and solutions are given. Maintenance requirements and life of gas-path parts are discussed.

A brief description of future activity, new basic designs, new features, and new installations is included.

The "Auris" Gas-Turbine Project.. .....58—GTP-12

By J. Lamb and L. Birts, The Shell Petroleum Company, Ltd., London, England. 1958 ASME Gas Turbine Power Conference (multilithographed; available to Jan. 1, 1959).

The "Auris" project has as its objective the development of gas-turbine propelling machinery for medium-sized tankers and other types of merchant ships.

The first phase, now successfully concluded, started with the installation, in the Shell tanker *Auris*, of 12,250 tons deadweight, of a 1200-hp gas turbine to supply about a quarter of the total propelling power. The results of five years' experience with this set confirm that the open-cycle gas turbine burning heavy fuel can find applications in medium-sized ships.

The second set, of 5500-hp, forming the sole means of propelling the ship, is now being installed in the *Auris*.

A summary of operating results with the 1200-hp turbine is presented. Operation of the compressor, heat exchanger, combustion chamber, high-pressure turbine, and such, are treated in detail.

The new 5500-hp gas turbine is also described in detail. It is designed for long life, burning any grade of residual fuel.

The turbines are multistage with uncooled rotors and casings, and the combustion chamber is refractory-lined. It is the sole means of propelling the ship.

A background and general outline of the installation and a discussion of all of the components are presented.

Gas Turbines for Blast-Furnace Blowing.....58—GTP-14

By G. H. Krapf, United States Steel Corporation, Chicago, Ill.; and J. O. Stephens, Westinghouse Electric Corporation, Lester, Pa. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

The steel-mill blast furnace consumes large quantities of coke, iron ore, limestone, and air. In addition to producing iron and slag, it also is a producer of large quantities of gas.

It has long been a challenge to the steel industry to develop equipment and means for utilizing more efficiently this by-product fuel.

The gas turbine was considered to be an acceptable and economical method of utilizing this gaseous fuel.

Tests simulating operating conditions on a gas-turbine combustor using blast-furnace gas were conducted. The favorable results of these tests led to the purchase of the gas-turbine blower.

The gas-turbine blower consists of two axial-flow compressors driven by a gas turbine. One compressor pressurizes the blast-furnace fuel gas from 8 in. of water up to 52 psia and the other compressor pressurizes air from atmospheric pressure up to 48.5 psia for the gas turbine and the cold blast air to the furnace.

A general description of the 125,000-cfm gas-turbine blower and comments on its operation are presented.

Lubrication

Some Factors Influencing the Area-Load Characteristics for Semi-smooth Contiguous Surfaces Under "Static" Loading.....57—A-246

By F. F. Ling, Assoc. Mem. ASME, Rensselaer Polytechnic Institute, Troy, N. Y. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

The relationship between the actual area of contact and normal load between contiguous surfaces for a large range of normal loads, in connection with the problem of friction in cutting processes, has been determined empirically by Finnie and Shaw. The so-called actual area of contact refers to the area projected on a plane perpendicular to the direction of the normal load; and, as such, the term has only qualitative or semiquantitative value.

In this paper the ideal case of "semi-smooth" contiguous surfaces is studied theoretically. That is, one of the surfaces is considered rigid and macroscopically smooth while the other one is allowed to have a large number of macroscopic asperities in the form of wedges. Under this restriction, actual area of contact acquires a definite meaning. The study is also limited to static loading; i.e., only relative motions resulting from plastic deformations of the wedges are permitted. The role the area-load characteristics play in the friction process and their relationships to the various theories of friction are discussed. Furthermore, some factors which may cause the area-load characteristics to be nonlinear are examined theoretically. These factors include strain-hardening, size of asperities, terminating levels of the asperities, and a statistical correlation between the shape and the starting level of asperities.

Influence of Pressure and Temperature on Oil Viscosity in Thrust Bearings.....57—A-275

By B. Sternlicht, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans.* ASME; available to Oct. 1, 1958).

Increase in lubricant viscosity under pressure has been the subject of considerable interest. Generally, most of the experimental work has been done at low rates of shear in order to neglect the influence of temperature on oil viscosity.

The theoretical analysis was made for an infinitely long slider, and in some cases, leakage factors were employed as correction factors.

Upon the request of the ASME Research Committee on Lubrication, a theoretical study has been undertaken to determine the influence of pressure and temperature on oil viscosity in finite-length thrust bearings. This paper points out that it is theoretically possible to determine the influence which pressure and temperature have on oil viscosity and, in turn, on bearing performance by solving the energy and Reynolds equations simultaneously. The oil viscosity in these equations is expressed as a function of temperature and pressure. This paper also presents solutions for several cases in which oil viscosity is assumed to be only a function of temperature. This is done so that the temperature effect will not mask the pressure effect and thus will permit separation of the two effects.

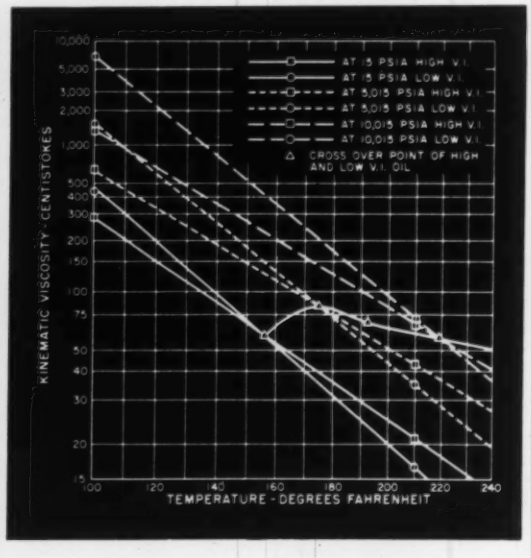
The paper presents pressure and temperature distribution, load-carrying capacity, oil flow, horsepower loss, and center of pressure for several minimum film thicknesses and two oil characteristics.

The Pressure-Viscosity Effect: Background.....57—A-277

By H. A. Hartung, Philadelphia, Pa. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

It is certainly common knowledge that when liquid lubricants are heated, they become less viscous. We have developed ways of estimating what the viscosity will be at any temperature within a moderately large range—a range large enough to cause the viscosity of some lubricants to vary by factors up to 10^6. Knowledge of lubricant viscosity at various operating temperatures is essential for the design of much of our modern machinery.

Less widely appreciated is the fact that lubricants may show equally large variations in viscosity with pressure. As with the temperature effect, the magnitude of the pressure effect depends on the nature of the lubricant. An effort is being made to set up a program which will attempt to determine whether or not the pressure effect is important to critical design, perhaps as important as the temperature effect. This paper broadly traces the development of knowledge of the pressure effect, and sets the background against which plans for a critical study of it may be judged.



Viscosity temperature properties for high and low-viscosity oil as a function of pressure (57—A-275)

Oil-Whip Resonance...57—A-169

By E. H. Hull, Mem. ASME, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

A series of oil-whip resonances has been demonstrated by applying a rotating force to a shaft running in a hydrodynamically lubricated bearing. These resonances appear at the ratios of shaft speed to exciting-force frequency of approximately 2 which is normal oil whip, 3, 4, 6, 8 . . . . and −2, −4, −6 . . . . The locus of the shaft center at these resonances traces a trochoid containing a number of loops related to the ratio of shaft speed and force frequency. Inside loops are formed at positive frequency ratios, outside loops at negative ratios. A qualitative explanation of the formation of these resonance figures is offered.

Theory of Oil Whip for Vertical Rotors Supported by Plain Journal Bearings.....57—A-171

By Finn Orbeck, Stabekk, Pr. Oslo, Norway. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Oil whip as defined in this paper is a result of the centrifugal force acting on a rotor due to its whirling motion. Since the oil film resistance to this force is a minimum for whirling motions at frequencies just below one half of the rotor rotation, oil whip will occur at this frequency. The amplitude of oil whip increases with increasing speeds and oil whip is not a resonance phenomenon.

This paper endeavors to show that a consideration of the force equilibrium of the journal in a journal bearing which is subjected to oil whip leads to two equations which describe this phenomenon in frequency and amplitude. The first equation determines the ratio of frequency of whirl to frequency of rotation in terms of the eccentricity ratio. The second equation relates the eccentricity ratio to the frequency of rotation. The foregoing equations therefore suffice to describe oil whip in frequency and amplitude. Numerical studies of the problem indicate some agreement with published experimental studies.

Hydraulics

Symposium on Laboratory Testing of Hydraulic Turbine Models in Relation to Field Performance.....57—A-124

A report of the session held at the 1956 Annual Meeting by G. Dugan Johnson, 1956 chairman, Hydraulic Prime Movers Subcommittee. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

This report includes, in full, the five prepared statements by representatives of major American manufacturers and, in condensed form, the written and oral discussions presented at the 1956 Annual Meeting. These discussions have been condensed by Mr. G. Dugan Johnson, the 1956 chairman of the Hydraulic Prime Movers Subcommittee, to reduce the over-all length of this publication and have not been edited by the respective authors. Therefore they may not reflect the intended and fully considered opinion of the parties quoted, and where this is the case these authors are particularly requested to submit written discussions, correcting or appending this record. The Summary has also been prepared by Mr. Johnson and reflects his personal and tentative summation of the points on which the panel members and discussers appear to him to agree. It was offered as a basis for discussion at the 1957 Annual Meeting, particularly by each panel member and discusser quoted in this report.

Application of the Analog Computer to Product Dynamic Performance in Typical Hydraulic Circuits..57—A-97

By Gerhard Reethof, Mem. ASME, Vickers Inc., Detroit, Mich. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

The successful use of electronic-analog-computing techniques in the simulation of typical hydraulic systems is demonstrated. As an example, the instabilities of a certain open-center hydraulic-booster system are simulated, and corrective action is indicated and verified. The study involves the analysis of a grossly nonlinear system and methods of function generation are given.

The example has shown that the electronic analog computer can be programmed to realistically simulate nonlinear hydraulic circuits. The validity of the simulation depends entirely on the ability of the analyst to realistically describe the behavior of the elements of the system by analytical means. Thus the analog computer will only solve the engineers' analytical interpretation of the system. If certain important distributed or lumped effects are neglected, the answers from a computer may be embarrassingly misleading. If, however, a reasonably accurate simulation is studied by the analog approach, an excellent physical understanding of the nonlinear system is obtained. As a result of this understanding, the time devoted to developmental experimentation will be greatly reduced.

Cavitation and Nuclei...57—A-80

By R. T. Knapp, Mem. ASME, California Institute of Technology, Pasadena, Calif. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Contrary to the general impression, water and other common liquids, when pure, have high tensile strength. Cavitation would be impossible at the highest velocities currently encountered. In practice, all liquids appear to cavitate as soon as the pressure tends to drop below the vapor pressure, thus implying that liquids have no tensile strength. This discrepancy is explained by the presence of "weak spots" whose characteristics have as yet only been inferred.

This paper presents the results of an experimental investigation of the weak spots present in ordinary water. The results are consistent with the model of the nucleus proposed by Harvey, but are apparently inconsistent with other models currently found in the literature.

After summarizing the results of the experimental program, the paper concludes with a series of implications concerning the engineering significance of the nuclei in industrial liquids.

Prediction of Flashing Water Flow Through Fine Annular Clearances..57—A-78

By A. Agostinelli and V. Salemann, Assoc. Mem. ASME, Worthington Corporation, Harrison, N. J. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

The flow of a flashing mixture of water and steam through smooth annuli of fine clearance has been investigated experimentally. Test data have been obtained with inlet conditions to 600 F and 3000 psi. Critical conditions have been observed experimentally up to these temperatures and pressures. With the assumption that the flashing mixture is homogeneous, a method for the prediction of flow and two-phase pressure drop is presented and discussed.

Contribution to the Stability Theory of Systems of Surge Tanks.....57—A-65

By Charles Jaeger, English Electric Company, Ltd., Rugby, England. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

The theory of stability for two surge tanks in series on the same tunnel is developed and discussed in this paper. The number of free parameters involved in the analysis is reduced to the point where a general discussion becomes possible. The effect of relative tank locations, diameters, and periods is discussed, and the importance of friction losses on the over-all stability is mentioned.

An Index of Cavitation Erosion by Means of Radioisotopes.....57—A-64

By S. L. Kerr, Fellow ASME, Flourtown, Pa.; and Kjell Rosenberg, A/S Hafslund, Sarpsborg, Norway. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

While much has been written about

cavitation and its effect on the performance of hydraulic turbine and pumps, the damage caused by it—cavitation erosion—is usually the manifestation that gives the most concern to the operating staff.

The relative resistance of materials of construction has been explored in a number of research investigations both in the United States and elsewhere.

The magnetostriction method used initially on a large scale in 1935, sometimes called the vibratory method, has now become a standardized means for evaluating various metals.

The correlation of experimental work with field experience, however, is the subject of much speculation. The areas where cavitation erosion is experienced in the field can often be identified from laboratory tests.

Protective means, such as prewelding critical areas in the shop with wear-resistant materials, has been employed with great success in a number of cases. The repairing of previously unprotected areas using highly resistant metals has also been effective in reducing subsequent cavitation erosion.

To relate laboratory tests to the actual operation of hydraulic turbines in the field, many factors must be considered:

1 Plant-cavitation factor or sigma (σ).

2 Loading of the units.

3 Accuracy of step up of the main unit from the laboratory model.

4 Variation in conditions between original design of the plant including changes in headwater and tail-water levels.

Few of these factors are under the control of the turbine manufacturer, although he is expected to produce an erosion-free unit in any case.

A problem concerning an economic balance between output and cavitation erosion existed at the Vamma Hydroelectric Plant in Norway. A detailed report on experiments in this field test is described in this paper.

Symposium on Welded Spiral Cases From the Consulting Engineers' and Users' Viewpoint.....57—A-106

1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

The symposium which included four papers discussed four different aspects of welded spiral cases.

"Hydraulic and Weight Features of Welded Spiral Cases" was discussed by R. A. Sutherland, Mem. ASME, Ebasco Services Inc., New York, N. Y. In this paper an illustrative example of comparative head loss of welded and riveted plate-steel spiral cases shows that a substantial monetary value may accrue by the use of a welded case. An approximate relationship for weight of case in terms of rated head, case-design head, and inlet diameter is derived and checked against known data.

"Welded Spiral Case Construction Procedures" was covered by G. R. Latham, Ebasco Services Inc., New York, N. Y. This paper discusses comparative costs between riveted and welded spiral cases, suggests requirements for insuring satisfactory welded spiral cases, under varying conditions, and sets forth construction and welding procedures being carried out on three different examples.

"TVA Experiences, Welded Versus Riveted Spiral Cases" was the subject of the paper by R. M. Gardner, Mem. ASME, Tennessee Valley Authority, Knoxville, Tenn. Erection and welding procedures carried out on Fontana, Hiwassee, and Watauga Units of the Tennessee Valley Authority, are described. Erection costs of both welded and riveted cases where such costs are comparable, are given.

"Pressure-Embedment of Spiral Cases" was discussed by B. G. Seitz, Bureau of Reclamation, U. S. Department of Commerce, Denver, Colo. It is the practice of the Bureau of Reclamation to pressure-test hydraulic-turbine spiral cases in the field at case-design pressure and to embed them under normal operating pressure. This paper gives reasons for this practice and describes some methods used.

Maintenance and Plant Engineering

Planning and Scheduling for Effective Maintenance Cost Control.....57—A-288

By S. Whitehead, American Cyanamid Company, Bound Brook, N. J. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

To meet the increased demand from keen competition, analyze carefully the contribution that maintenance is making to the cost of each product manufactured. A substantial contribution can be made by improving the effectiveness of planning and scheduling in the maintenance department. By analyzing and planning the work load over a year, encouraging the trends toward more long-range work and more routine work, by adjusting and simplifying manpower requirements, and by proper scheduling of the work-load efficiencies will be effected. Next by evaluating accurately the effect of the department's expenses in the over-all cost of manufacturing, it will be possible to appreciably reduce maintenance cost. The integration of these various elements of planning and scheduling in the basic maintenance objective will be lower maintenance cost per unit produced, the final objective.

Maintenance Cost Control.....57—A-287

By J. C. Jessen, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Many maintenance executives are faced with the problem of maintaining plants containing production equipment unheard of ten years ago. To assist them in this difficult task, this paper presents discussion of the basic problems created by automatic control and continuous plant operation and a brief discussion of all necessary components of a complete maintenance system showing how they are interrelated. This system has been successfully used by du Pont to reduce maintenance costs and equipment down time.

The primary effort of a works engineer is to assist his works manager reduce the mill cost of a product to a minimum without sacrifice of product quality or employee safety. Normally, the proper safe control and reduction of mill cost result from the control and reduction of maintenance costs. In some cases, however, it may result from an actual increase in maintenance costs in order to reduce equipment down time to a minimum to obtain greater productivity.

A system of 18 basic tools for cost control and increased output follows: (1) Set up proper maintenance organization; (2) establish a work order system; (3) keep equipment records; (4) analyze and plan jobs; (5) make weekly forecasts; (6) prepare daily schedules; (7) set up manpower backlog control; (8) establish a preventive maintenance program; (9) use budgetary control; (10) provide material control; (11) plan your plant shutdowns; (12) set up major overhaul procedures; (13) develop standard practices; (14) use work measurement; (15) improve your equipment; (16) train your supervisors; (17) train your maintenance men; and (18) analyze performance and costs.

Instruments and Regulators

On-Off Control With Periodic Sensing Device.....57—A-207

By K. Izawa, Purdue University, Lafayette, Ind. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

The paper describes theoretically the effectiveness of PD (probability density) type control function for the on-off control system with a periodic sensing device. When the system is disturbed by a steady random disturbance provided that the disturbance is varying rather slowly compared to the time constant of the controlled plant, the properly chosen PD control action can effectively decrease magnitude of fluctuation of controlled variable.

Development of the Generalized Phase-Diagram Method.....57—A-216

By P. M. LeFevre, Municipal Laboratory of Paris, Paris, France. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

For a long time, the stability of linear systems has been studied by means of the Hurwitz or the Routh criteria both of which use coefficients of the characteristic equation with the terms ordered according to increasing or decreasing powers of the variable. The application of these criteria becomes rapidly more difficult when the equation considered is of higher order.

The harmonic method of Nyquist and the method of Leonhard, devised in order to study electronic amplifiers, were used extensively during the last war and particularly in the United States where many research workers applied the Nyquist criterion to the study of servomechanism stability.

A few years ago the study of the stability of complex systems governed by a ninth-order differential equation, where the Nyquist criterion could not be applied, was begun.

A new harmonic method for studying the stability of linear systems was developed. This method is deduced from the Cauchy residue theorem, and constitutes a generalization of the Nyquist criterion. It is the "graphical method of the generalized phase diagram" published in the *Revue Générale de l'Electricité*.

In the present paper, the graphical method mentioned above is reviewed briefly. Some developments follow:

A rule for interpreting the phase diagram.

A theorem concerning the essential instability of certain linear systems.

Among the results already published which are not treated in this paper, the graphical method for the study of an interval of stability must be mentioned. This method, which gives the variation curve of the guaranteed damping of a given system, has led to some fruitful developments in the determination of corrective networks.

Design Analysis of a Helicopter Rotor-Speed Governor..57—A-210

By P. J. Hermann, Goodyear Aircraft Corporation, Akron, Ohio. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The use of frequency-response techniques was developed by the electronic communications industry as a means of analyzing and synthesizing complex communications systems. During World War II these techniques were extended to the analysis and synthesis of electromechanical and mechanical automatic control systems. Since then there has been increased adaptation in this field. The purpose of this paper is to illustrate the application of frequency-response and electronic analog-computer techniques in the analysis of a helicopter rotor-speed control system and in the synthesis of an engine throttle controller.

Goodyear Aircraft Corporation, under Air Force contract, is to design and construct a throttle-actuating controller that will maintain the rotor speed of a helicopter constant within specified limits. The control is to be effective in both hovering and forward flight and is to counteract disturbances of vertical gusts, load changes, autopilot-pitching control, and blade-collective-pitch hovering-altitude control.

Analytical techniques utilized linearized and simplified differential equations of motion to describe the dynamic behavior of each system component. Frequency-response plots in the form of Nyquist diagrams were constructed from these equations. Synthesis of the throttle-controller specifications was done by introducing controller transfer functions that would modify the Nyquist diagram and optimize control response.

Survey of Mathematical Methods for Nonlinear Control Systems.....57—A-104

By J. M. Loeb, Schlumberger Well Surveying Company, Paris, France. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

This paper is a survey of presently known mathematical methods applicable to nonlinear control problems. After emphasizing the need for general theories which alone can facilitate equipment design, the author discusses: (*a*) Phase-plane and phase-space methods for graphical representation of general system behavior; (*b*) describing-function analysis of limit cycles; (*c*) piece-wise linear analysis; (*d*) probability calculus for the study of noise and random inputs in nonlinear systems; and (*e*) energy-balance and stroboscopic methods which apply to particular features of a system.

Considerations in the Instrumentation of Boiling-Water and High-Temperature Sodium Reactors.....57—A-191

By R. N. Brey, Jr., and J. M. Finan, Leeds & Northrup Company, Philadelphia, Pa. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Details of instrumentation as applied to a boiling-water power reactor are outlined. Various measurement and control systems are covered with mention of materials that must be used in primary elements and piping to withstand the special environmental conditions. Primary-element and measurement systems associated with a sodium-cooled fast-breeder power reactor also are discussed. Attention is given to materials of construction and considerations pertaining to high-temperature sodium applications of primary elements for temperature, pressure, flow, and level. Double-containment-philosophy also is outlined.

Wood Industries

Research in New Abrasives.....58—WDI-1

By E. J. Sterba, Skil Corporation, Chicago, Ill. 1958 ASME Joint Wood Industries Conference paper (multilithographed; available to Jan. 1, 1959).

Approximately two years ago, the first sample of a revolutionary new type abrasive, Perma-Grit, was produced. This abrasive uses crushed and graded tungsten carbide supplied by Kennametal, Inc.

This carbide, graded and sorted the same as the grits used by the sandpaper industry, was brazed to steel through a special process. Each grit was permanently bonded to the face or edges of steel plates and, in many cases, to special

forms which indicated that there was no limit to the design of the abrasive or cutting tool that could be produced.

The permanent bonding of each grit to the surface of the steel produced a tool capable of cutting or abrading with almost indefinite life, owing to the ability of each grit to do its over-all operation without being loosened from the bond, moving away from the point of high resistance which would be common to grits held by a resinous or glue bond. Details of the development of this new abrasive are given in the paper.

Performance Characteristics of Small Spring-Set Circular Ripsaws .....58—WDI-2

By E. Y. Wheeler, F. B. Wilkie, Buffalo, N. Y.; and R. J. Hoyle, Jr., Mem. ASME, College of Forestry, State University of New York, Syracuse, N. Y. 1958 ASME Joint Wood Industries Conference paper (multilithographed; available to Jan. 1, 1959).

Collected information on the performance characteristics of woodworking tools can be of use to wood products manufacturers. Development of detail planning of production has been the pattern in manufacturing industries as a whole. In wood products manufacturing, various stages of this evolution are evident and the rate at which it will go forward will depend to some extent upon our ability to develop a body of factual information on tool behavior. The competitive position of the wood-products industry depends upon the reduction of costs in many areas and tooling is, of course, one of them. Progress in the accumulation of needed information has been most encouraging in recent years and it is not difficult to visualize the time when the wood industry tool planner will have at his disposal much more comprehensive information than has been available in the past.

The purpose of this paper is to place on record the results of an evaluation of performance of small spring-set circular saws for ripping. The effects of tooth geometry upon power consumption have been measured. The results present a composite picture of the effect of variations in saw-tooth profiles which are under the control of the saw filer and the manufacturer. Development of new saw designs has been extensive, not only in the tooth geometry of saws, but also in the materials used for the cutting edges. The information presented in this paper is specifically related to the spring-set circular saw used for cutting parallel to the grain. However, the principles studied can be extended to other types of saws and serve the designer, user, and research investigator. The special limitations, together with the advantages, of other tool materials must be considered in the application of these results.

Aviation

A Comparison of Power Extraction Methods for Two-Spool Turbojet Engines.....57—A-292

By E. M. Ramberg, Assoc. Mem. ASME, Titeflex, Inc., Springfield, Mass. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

As aircraft are designed to fly farther, faster, higher, and with larger payloads, the problem of providing auxiliary power becomes increasingly acute. Not only is more and more power being demanded, but also, as service ceilings are increased, the amount of energy used to drive motors, alternators, pumps, and a host of miscellaneous gear becomes a larger percentage of available propulsive power. What amounts to only one or two per cent at sea level may become eight or ten per cent of available propulsive power at extreme altitude.

In view of this, the inherent effectiveness of the method of extracting auxiliary power becomes an important consideration. Today, extraction methods on turbojet engines can be divided conveniently into two categories—air bleed and mechanical extraction.

In the air-bleed method, air is extracted from some point in the engine, usually before combustion. This air is then used to drive air turbines which are coupled to the accessories. Mechanical power extraction includes all methods of driving accessories by coupling the accessories to one of the turbojet rotors. The coupling may be direct as in conventional gear drives or it may be indirect in that a hydraulic or pneumatic pump may be driven from the turbojet rotor and the fluid power transmitted to motors which, in turn, drive the accessories.

The relative effectiveness of extracting power for driving engine and aircraft accessories by air extraction is compared with mechanical extraction for two-spool turbojet engines. All other factors being equal, it is shown that the thrust loss resulting from air-bleed extraction is greater than the thrust loss for extracting the same amount of power mechanically. The magnitude of the difference is $1/h_{ua}$ where h_{ua} is the maximum useful enthalpy of bled air per pound.

Air Freight Operation..57—A-291

By A. V. Norden, Seaboard & Western Airlines, Inc., New York, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The standards of performance which are required of new ground equipment and what criteria are to be used in determining what is the correct equipment dollar investment are considered.

The development of ground-handling equipment has not kept pace with high-speed aircraft development. There appear to be only two solutions to this ground-handling problem:

1 An end-loading airplane. This would provide either front or rear loading, and would eliminate fork lift side loading.

2 The development of new ground-handling equipment which will reduce loading time.

Economic Impact of Small Turbojets Upon Plane Design and Operations.....57—A-293

By L. W. Davis, Fairchild Engine & Airplane Corporation, Deer Park, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Studies of the potential of the small turbojet in the 1000 to 3000-lb thrust category have brought about the following conclusions:

1 The great promise of gas-turbine power for aircraft will never be fully realized while we continue to concentrate our design and development efforts only toward high-thrust, heavy-power packages.

2 The universal application of the turbojet, its use in many types of useful aircraft for which large power plants are unsuitable, can be achieved only if the designer has available a wide variety of engines in small, medium, and intermediate thrust ratings.

3 The cold, hard facts of economics in the design, production, and operation of turbojet aircraft dictate that we re-examine and re-evaluate the problems created by our preoccupation with large engines.

A Systems Approach to the Jet Noise Problem.....57—A-285

By L. R. Hackney, Mem. ASME, Air Logistics Corporation, Pasadena, Calif. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Noise has received legal recognition in the form of penalties for causing any "unreasonably loud, disturbing, and unneces-

sary noise" or noise "of such character, intensity, and elevation to be detrimental to the life or health of any individual."

The spectrum of human toleration to jet noise is extremely broad. At one end of the scale are aircraft and engine manufacturers, and others who, because of their affiliation, tend to regard noise with academic detachment. At the other is the general public who feels that it is an unwarrantable intrusion on their daily lives. In between are those who have to accept noise as a means to an end. In this category are operators of aircraft and, to a lesser extent, airline passengers.

Noise emanating from an aircraft can be divided into two broad categories—airborne noise and ground noise. The probable duration and intensity in each of these classifications are analyzed in an endeavor to determine which is likely to have the most over-all nuisance value.

Advanced Flight-Test Instrumentation Used to Develop Turbojet Engines.....57—A-224

By C. L. Shumate, General Electric Company, Edwards, Calif. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A brief history of General Electric's growth in flight-test instrumentation is given. A discussion of the role telemetering has played in several of the flight-test programs points out how valuable telemetering can be in conducting such programs. The plans of in-flight monitoring of telemetered data in the radio room are presented. This is followed by a proposed flight-test data acquisition and processing system based around an airborne tape recorder with the information being recorded on tape by use of analog and pulse-code-modulation techniques.

A New Concept in Lightweight Aircraft—The Northrop T-38 Trainer.....57—A-294

By W. E. Gasich, Northrop Aircraft, Inc., Hawthorne, Calif. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Many studies and predictions have been made on the use of the newly developed lightweight turbojet engines. This paper concerns a specific application of these engines, the Northrop T-38 Supersonic trainer. Designed to provide an economical, high-performance replacement for the T-33 in the basic trainer role, the T-38 exemplifies the use of advanced technology in satisfying a given military requirement.

Early Experience in Flight Tests With T-53 Powered Helicopters.....57—A-295

By L. L. Middaugh, AVCO Manufacturing Corporation, Lycoming Division, Stratford, Conn. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Flight-test results with the Lycoming YT-53-L-1 free power turbine engine installed in the modified Kaman HOK-1, and the Bell XH40 helicopters have, as of May 1, 1957, produced the following conclusions:

A preliminary evaluation of engine operation to 15,000 ft was completed with a surplus of power available for testing at greater altitude.

Operation of the engine and its accessories were found to be satisfactory. Temperatures were well within specified limits to the 75 F ambient air thus far encountered around the engine and nacelle area.

Noise levels were found to average 10 to 12 db lower on the HOK (T-53) in comparison with those of the standard HOK-1 (R-1340) installation. The effect of acceleration/deceleration lag, inherent in turbine engines, has been minimized through the use of a differential/collective pitch mechanical linkage with the power-turbine governor. Power response now compares most favorably with that of reciprocating engine installations.

T-58 In Flight.....57—A-290

By N. N. Davis, General Electric Company, Lynn, Mass. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The T-58 engine was developed by General Electric and the Navy's Bureau of Aeronautics to fulfill helicopter requirements for a gas-turbine engine in the 800-1500-hp class. The helicopter industry had for some time been investigating engine power and operational requirements to determine the most desirable gas-turbine power plant. Through these investigations, certain basic requirements were found to be essential to high performance helicopter operation.

It was not until the latter phases of these investigations that the final T-58 engine configuration was determined. Consequently, engine performance guarantees were selected which appeared to give adequate margin for horsepower, specific fuel consumption, and engine weight, but which would also allow a design capable of extremely fast power response, durable, and simple to service and overhaul. At this point in the T-58 development calendar, minimum performance guarantees were established for the first production model.

The T-58 engine is a free turbine design consisting basically of the gas generator and free turbine assemblies. It is described in detail and the engine-improvement program is also outlined. The compressor, combustor, and fuel control are discussed. The model test, helicopter rotor test, and the over-all flight-test program are noted.

Ground Equipment Requirements for the Jet Transport Aircraft.....57—A-298

By J. T. Dyment and H. J. Curtis, Trans-Canada Air Lines, Montreal, Quebec, Canada. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

How can ground operations be streamlined? The answer: By using improved methods of materials handling, by using more machine power and less manpower, by reducing where possible the amount of portable equipment that literally surrounds the aircraft. More could be accomplished, if the aircraft on the ground and the terminal building could be integrated.

In discussing some of the aspects of effective ground handling facilities, the authors consider maneuvering of the aircraft, docking, electrical power, fueling, oil, engine water, galley servicing, and so on.

An "Airborne" Cargo Handling System and Its Influence on Operating Costs.....57—A-297

By P. L. Smith, Douglas Aircraft Company, Tulsa, Okla. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The incorporation of an airborne cargo handling system, which has been specifically designed to facilitate loading, unloading, and tie-down, offers numerous advantages to air-freight operators. First of all, ground time can be reduced, thereby promoting higher productivity. Furthermore, a system for cargo handling can provide greater flexibility of operation, which will in turn result in higher utilization of the fleet. The hourly operating cost will be reduced because of: (*a*) reduced hourly depreciation rate, (*b*) reduction of indirect manpower, and (*c*) downgrading of required skills.

Secondary Power and Accessory Problems in Tomorrow's Air Weapon System.....57—A-296

By H. R. Shows, Wright Air Development Command, ARDC, Wright-Patterson AFB, Ohio. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Secondary power subsystem compo-

nents will play a key role in tomorrow's boost glide and satellite type of air vehicle. Of prime importance is the power source that will provide energy to operate accessories in the vehicle for long periods of time. The secondary power source may also be the prime propulsion source for certain parts of the vehicle mission.

The feared temperature problem does not represent a barrier in allowing the secondary power to maintain a progress consistent with the remainder of the vehicle. However, the term "thermal thicket" is still a very appropriate title for the temperature problem.

New environments, both natural and induced, will play an important part in the design problems for tomorrow's secondary power subsystems and accessories. Test facilities will detain progress in this area, especially of the type that can simulate more than one environment simultaneously.

Because of the importance of improvement in the area of secondary power a closely integrated and co-ordinated program by industry is needed. The limited production will curtail many contractors investing their money into the research and technical development areas. Therefore, whenever possible, each engineer should take advantage of other engineers' work. The respective technical societies and associations will play an important part in this exchange of ideas.

There is a need for industry to co-operate to the fullest when government contracts are let to study and determine status and potentials on a subsystem or area basis. Actually, the success of the prime contractor on such studies is very dependent upon the co-operation of the remaining part of industry. By such co-operation the government will not only be able to make available the results of the study but, of prime importance, will be able to furnish better guidance to industry in the form of technical requirements, research planning objectives, and system requirements.

Why Quickening Works. 58—AV-9

By H. P. Birmingham and F. V. Taylor, United States Naval Research Laboratory, Anacostia, Md. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Quickening has been defined as any modification to a closed-loop man-machine control system which reduces the need for the human operator to perform analog differentiations or separately to sense and utilize derivative information. Therefore if a system is fully quickened and unburdened (in a fully "unburdened" system, it is unnecessary for the human operator to perform integration) the requirements of system performance will be satisfied if the human operator performs as a simple amplifier.

In a well-designed, quickened, man-machine control system, precise system performance is obtained because:

1 The amount of analog processing by the human is minimized, resulting in greater bandwidth being provided by the man.

2 The necessary analog computation is performed by mechanical or electrical elements which are far more precise than the human.

3 The gain factors and transfer functions of various parts of the system are precisely determined in advance by the engineer rather than arrived at by the human's trial-and-error process.

4 The effect of human "noise" on system performance is reduced.

5 The effect of human gain fluctuation on system performance is minimized.

High-Energy Aviation Fuels—Their Promises and Problems. 58—AV-26

By R. A. Wells, Gulf Research & Development Company, Pittsburgh, Pa. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

High-energy fuels mean many things to many people. To the aircraft-engine manufacturer it means a fuel which will allow his present and/or future models to produce more power than they would on present fuels. To the air-frame manufacturer it means a fuel which can be squeezed into smaller tanks and/or will not weigh as much as present fuel for the same aircraft range. To the aircraft operator it means a fuel which will enable him to carry more passengers or cargo faster for longer distances at lower direct operating costs. To the fuel supplier it means a material one of his competitors has come up with just to take his customers' business.

The approach to this subject is a review of the state of the art of applying high-energy fuels to a series of different power plants to give improved vehicle performance. For air-breathing engines, high-energy fuels are usually compared on the basis of heat release per unit weight of Btu/lb; but there are also other bases which sometimes overshadow Btu/lb, such as Btu/gal for space limited aircraft and flammability limits where extremely high altitude performance is desired. These are included in the comparison.

For rocket engines, which do not use the air as their source of oxygen to burn their fuel, energy level is compared on the basis of specific impulse. Specific impulse or I_{sp} is pounds force of thrust developed/mass of propellant exhausted/second and is a measure of the difference in total heat of propellant gases before and after expansion.

On a Stationary Temperature Separating Device Used as a Measuring and Cooling/Heating Apparatus. . . . . 58—AV-28

By P. H. Savet, American Bosch Arma Corporation, Garden City, N. Y. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

An instrument, known as a vortex tube or Hilsch tube, used either as a cooling or a static temperature measuring device is the subject of this paper. Its use as a static temperature probe is attractive, and since it has no moving parts, it is easy to construct and use. Over-all efficiency of the tube, if used as a cooling device is poor, although its intrinsic efficiency is high enough to offer little hope of improvement, if utilized by itself. Careful analysis of the device is necessary fully to understand its operation and use it properly.

Force-Balance Pressure-Measuring Sensors. . . . . 58—AV-18

By G. P. Knapp, Servomechanisms, Inc., Westbury, N. Y. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Force-balance pressure sensors appear to be the immediate answer to the requirement for accurate measurement of pressure altitude, Mach number, and other related quantities. Transducers built around these sensors are performing to accuracies of $^1/_4$ per cent of altitude and 1 per cent of Mach number or better up to 80,000-ft altitude and Mach 3. The fact that these devices were only a gleam in the eye of the designer 5 years ago gives promise that further intensive development will produce even better performance.

Total Temperature Measurements. . . . . 58—AV-17

By F. D. Werner, Rosemont Engineering Company, Minneapolis, Minn. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

The history of the development of total temperature probes is reviewed briefly, starting with the diffuser probe developed by Franz, including various simplifications and refinements of this type probe. The other probe types described are a simplified type which omits the diffuser, types in which heat-conduction errors are suppressed, types

which include radiation shields, and deiced types.

One of these designs having almost negligible conduction errors, no diffuser, and radiation shields, which is identified as the MA-1 probe, is described in considerable detail since a great deal of information exists on its recovery errors, radiation errors, time constant, self-heating effect, angle of attack sensitivity, drag, and calibration accuracy. Where possible, it is compared with the other total temperature probe types.

An example is given of a complete error analysis for this probe. The various considerations involved for proper installation are outlined.

Servoed Pressure Transducers as Air-Data Inputs.....58—AV-16

By S. E. Westman, The Garrett Corporation, Los Angeles, Calif. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Current interest in air-data instruments is centered about the difficulty of determining pressure altitude, Mach number, and similar quantities, at altitudes where we are running out of air to measure.

The same instruments must make relatively high-pressure measurements at sea level. Critical needs for wide-range pressure measurements are being met by pressure transducers of the servo-follow-up, and variable-spring, variable-geometry, or parametric force-balance types. These types and their adaptability to the more difficult airborne requirements are discussed. The instrument industry's internal problem in the calibration of high-accuracy transducers is discussed.

Designing Controls for Human Use. .....58—AV-10

By J. H. Ely, Dunlap and Associates, Inc., Stamford, Conn. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Although much recent work in the field of human engineering (engineering psychology) has dealt with the more sophisticated aspects of man-machine systems, the basic work concerned with control design has been continued and now represents a major effort in this field. The purpose of this paper is to identify and discuss briefly the significant factors in control selection and design in so far as human performance is concerned.

Among the important factors to be considered in control selection are the following:

1 Controls should be selected so that the various limbs of the body are used.

2 It is desirable but not essential that the greatest load be given to the right hand since this is the preferred hand for most people.

3 Foot controls, when used judiciously, are quite acceptable.

Each of these is discussed in some detail. Control coding is also noted and the relative merits of size, shape, and color coding are indicated. Also included is a discussion of controls resistance.

Air Conditioning the B-58—A Progress Report.....58—AV-21

By J. I. Koger, Assoc. Mem. ASME, and W. B. Bennett, Convair, Fort Worth, Texas. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

The task for which the B-58 air-conditioning system is designed and intended is much more than the term air conditioning might imply. The B-58 system performs many functions. Primarily, it pressurizes the crew compartment, some units of electronic equipment, and the fuel tanks; it cools (or in some instances, warms) the crew members, the electronic equipment, and the structure; and it removes rain from the pilot's windshield, fog or frost from inside the pilot's enclosure, and ice from the engine inlets. In addition, the warm-air manifold has the secondary purpose of serving as the engine-starter air manifold.

The design objectives for the development of the air-conditioning system were simple enough: Install a system capable of the functions previously mentioned requiring the smallest weight conceivable, the lowest drag, and the least quantity of engine bleed air.

The high lights of developing a proposed air-conditioning system into an operational part of the airplane are given, as are the improvements made as a result of flight testing and operational experience with the airplane.

Power

Treatment of Make-Up Feedwater, Condensate and Recycle Water for Supercritical and Nuclear Reactor Power Plant Cycles....57—A-198

By V. J. Calise, Mem. ASME, and J. H. Duff, Graver Water Conditioning Company, New York, N. Y. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

A comprehensive view is presented of treatment of water in such power plants of the future as the supercritical and nuclear power stations.

The requirements of hitherto extraordinary water quality and absolute dependability of performance within supercritical and nuclear power cycles have developed four essential factors which must be taken into account in the design of suitable water-treatment equipment.

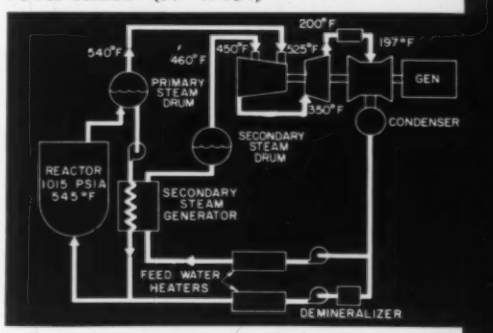
Details are presented for each of these factors. Supercritical - pressure boiler plant water treatment, points of difference in water cycles, nuclear power plant water treatment, and factors in design of water-treatment equipment are also discussed. A glossary of terms and an extensive bibliography complete the paper.

Investigation of Erosion and Corrosion of Turbine Materials in Wet Oxygenated Steam....57—A-134

By H. A. Cataldi, C. F. Cheng, and V. S. Musick, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Steam from the boiling water reactor of the Dresden Nuclear Power Station will enter the turbine at 869 psia and 525 F with $^1/_2$ per cent moisture, and with oxygen concentration higher than normal in power-plant practice. This paper discusses a series of preliminary laboratory tests evaluating the resistance of various materials for turbines and related components to erosion (impact, washing, wire-drawing and corrosion weight loss, pitting depths, crevice, and galvanic attack) in wet, oxygenated steam. Materials tested included carbon and low-alloy steels, and cast iron, austenitic and ferritic stainless steels, Monel, cupronickels, leaded bronze, Stellite and Ductile Ni-Resist No. 3. It is concluded that, with proper design, conventional materials may be used in the Dresden turbine except in a few critical areas.

Flow diagram of Dresden Nuclear Power Station (57—A-134)



Management

Financing for the Future.....58—MGT-7

By R. M. Kelmon, Boston Edison Company, Boston, Mass. 1958 ASME-AIEE Joint Engineering Management Conference (multilithographed; available to Jan. 1, 1959).

An appraisal of future financial costs will include a survey of the economic situation, since the total demand for additional funds will be predicated on the over-all business activity of the economy. The cost of borrowing these funds will depend on the ability of the financial industry to supply them in relationship to the effective demand. The monetary policies of the Federal Reserve System and their proximity of actions to the government securities market and commercial bank financing also will be effective. The source of funds, internal or external, and the amounts acquired in each instance, will have a bearing on the ultimate costs to a corporation contemplating additional financing. A critical study of one's capital expansion plans, coupled with a proper sense of financial timing, could help to make a company's financing economical.

Evaluation of Technical Programs.....58—MGT-3

By L. W. Bass, Arthur D. Little, Cambridge, Mass. 1958 ASME-AIEE Joint Engineering Management Conference paper (multilithographed; available to Jan. 1, 1959).

Advanced technology in industry requires that research, development, and engineering be co-ordinated closely. The success of American management depends upon developing proper procedures for accomplishing this objective.

Effort is made to note procedures for the evaluation of technical programs.

It is suggested that a technical audit providing unbiased analysis of technical activities be employed to supply four basic recommendations to management:

1 What does or should management expect of its technical departments in the way of new and improved technology?

2 Are the technical programs designed to meet these objectives, both in regard to coverage and scope?

3 Is the technical organization geared to provide the required results?

4 Does the company effectively translate technical information into commercial benefits?

Ways in which management might satisfactorily answer these questions are presented in a discussion of corporate objectives, organization of technical effort, budgeting of research and development, operation of a technical department, and utilization of results.

Competitive Position as a Measure of Engineering Progress.....58—MGT-6

By O. E. Rodgers, Mem. ASME, Utica Bend Corporation, Utica, Mich. 1958 ASME-AIEE Joint Engineering Management Conference paper (multilithographed; available to Jan. 1, 1959).

An awareness of competition and a continuous evaluation of the competitive position are musts for every engineering management, whether the products of the engineering operation are sold on a technical or nontechnical basis.

A review is presented of the usual ways of obtaining information on competitive products. It is not necessary to employ semiethical tactics in order to obtain sufficient information on competition.

Information on competitive products is available in the form of sales literature, purchase and evaluation of competitive products, results of sales department negotiations, technical papers, customer inquiries, suppliers, company announcements, and gossip. The first four items provide information on present competition. The remaining items provide information on future plans and programs which might intensify competition in the future.

General methods of using competitive information in engineering program planning are discussed as related to several different types of competitive situations.

Planning and Control of Integrated Design and Construction Projects.....58—MGT-4

By J. J. Niland, Stone & Webster Engineering Corporation, Boston, Mass. 1958 ASME-AIEE Joint Engineering Management Conference paper (multilithographed; available to Jan. 1, 1959).

The role of the project engineer is one that requires as much managerial ability as it does engineering talent. Ideally, he should be instinctively decisive, but restrained by his training and special knowledge from making quick decisions without careful analysis. Furthermore, he must be able to communicate with people. In addition to co-ordinating the work of the other engineers, which is primarily keeping them informed, he must be convincing in his recommendations to the client and precise in his instructions to the drafting room. Since these requirements apply to the management of any enterprise, we find that the successful project engineer is both a good engineer and a competent administrator. That such a combination is not altogether commonplace should be obvious, and wise management will recognize that the most important asset of an engineering organization is its people.

Integrating Technical Effort in Long and Short-Term Programs.....58—MGT-2

By G. R. Northrup, Philco Corporation, Philadelphia, Pa. 1958 ASME-AIEE Joint Engineering Management Conference paper (multilithographed; available to Jan. 1, 1959).

The growth of technological developments during and since World War II has stimulated competition among industries to develop new products, new processes, and new markets. A natural trend to diversification and development of families of products, and exploratory studies of new products has resulted in the growth of competition. In view of this, many companies are evaluating how and where their technical effort is being expended and how the greatest return on investment for technical manpower can be realized.

Planning Facilities in the Face of Rapid Obsolescence...58—MGT-1

By S. W. Herwald, Mem. ASME, Westinghouse Electric Corporation, Baltimore, Md. 1958 ASME-AIEE Joint Engineering Management Conference paper (multilithographed; available to Jan. 1, 1959).

Facility plans in a rapidly advancing technology require the same flexibility as do the development programs. Facility planners require knowledge of the present state of the art, present facilities, and expected advances in the art. The facility plans have a considerable effect upon the future welfare of an organization. They deserve top-level attention. They can mean the difference between company youth and senility. In short, the place for facility planning goes hand in hand with the most advanced planning carried on within an organization.

Machine Design

An Automatic Single-Fiber Tensile-Strength Tester.....57—A-158

By P. C. Wharff, Jr., Mem. ASME, and R. A. Crane, The Dow Chemical Company, Pittsburgh, Calif. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A recently developed automatic single-fiber tensile tester obtains large amounts of stress-strain data for production control. The instrument tests fibers at a maximum rate of 30 to 40 samples per hour and plots stress-strain curves which are corrected for denier (cross-sectional area), corrected for mounting-length errors, and includes an indication of the denier of each sample. The elastic-modulus portion is plotted at twice the sensitivity of the balance of the curve. Ease of use is gained through the application of a "drop-in loading" design.

Availability List of Unpublished ASME Papers

A NUMBER of papers and reports were presented at ASME Meetings which were not preprinted or published. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th Street, New York, 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 45 cents per page to members; 50 cents per page to nonmembers. The following papers recently have been placed on file in the Engineering Societies Library:

1957 ASME Region I—Management Conference

The Management of Engineering Personnel, by F. L. Ryder

1957 ASME Fall Meeting

The How of Safe Design, by H. H. Mabie

The Virtues of Chill Cast Surfaces for Various Applications, by E. V. Black

The Evaluation of Ductile Iron as an Engineering Material, by A. A. Avedisian

Mechanical Properties of Gray Cast Iron, by T. E. Eagan

1957 ASME Annual Meeting

Metallurgical Design and Fabrication Problems in Pressure Vessels for Nuclear Power, by L. W. Smith and R. E. Lorentz, Jr.

Fort Randall Hydraulic Turbine Modification Field and Model Tests, by J. B. Holt

Trends in Equipment Design, by C. E. Killebrew

Integration of Knowledge and Know-How, by E. J. Opitz

Planning Safety Into Automation, by T. E. Seavey

Materials Handling Analysis by Travel Charts, by W. P. Smith

Should Purchasing be a Mattet of Material and Construction Specification or Functional Specification? by J. D. Loftus

Plastic Glazings for Solar Energy Absorption Collectors, by F. E. Edlin

"Teflon" 100X Perfluorocarbon Resin—Properties and Applications, by R. S. Mallouk, J. C. Siegle, and H. A. Straw

Selected Problems in Aviation Acoustics, by H. O. Parrack

1958 Joint ASME-ARS Aviation Conference

Heat-Flux Measurements in the Discharge of Fluid-Stabilized Arcs, by J. H. Bonin and W. P. Manos

Studies Concerning Mass Ablation Caused by Severe Heating, by J. B. Gilstein, H. W. Wachman, and Y. A. Yoler

A Mach 4 Rocket-Powered Supersonic Tunnel Using Ammonia-Oxygen as Working Fluid, by R. W. Graham and E. C. Guentert

1958 ASME-AIEE Railroad Conference

The Engineering Problems of Building Railways in Northern British Columbia, by R. E. Swanson

ASME TRANSACTIONS

THE May, 1958, issue of the *Transactions of the ASME* (available at $1 per copy to ASME members; $1.50 to nonmembers), contains the following technical papers:

Boundary Layer Along Annular Walls in a Swirling Flow, by Hsuan Yeh. (57—SA-22)

Stall Propagation in a Cascade of Airfoils, by A. H. Stenning and A. R. Kriebel. (57—SA-29)

Losses in Flow Normal to Plane Screens, by W. G. Cornell. (57—F-19)

The Effect of Heat Conductance on Slider-Bearing Characteristics, by W. H. Guilinger and E. A. Saibel. (57—SA-90)

Influence of Load and Thermal Distortion on the Design of Large Thrust Bearings, by R. A. Baudry, E. C. Kuhn, and W. W. Wise. (57—SA-73)

Oil Seals to Provide Positive Lubrication on Large or High-Speed Thrust Bearings, by R. A. Baudry, G. E. Peterson, G. D. Cooper. (57—SA-74)

The Behavior of the Lubricating Film and Side Leakage in Dynamically Loaded Bearings, by M. N. Özdas. (57—LUB-5)

Interpreting Dynamic Measurements of Physical Systems, by S. Lees. (57—A-103)

Solution of Reynolds' Equation for Finite Journal Bearings, by O. Pinkus. (57—F-12)

Theoretical and Experimental Analysis of Hydrodynamic Gas-Lubricated Journal Bearings, by B. Sternlicht and R. C. Elwell. (57—F-18)

The Variable Fluid-Property Problem in Free Convection, by E. M. Sparrow and J. L. Gregg. (57—A-46)

Laminar Film Condensation of Pure Saturated Vapors on Inclined Circular Cylinders, by Kamal-Eldin Hassan and Max Jakob. (57—A-35)

The Third Law of Thermodynamics: A Half-Century Appraisal of the Nernst Heat Theorem, by J. H. Potter. (57—A-185)

The Effect of Conduit Dynamics on Control-Valve Stability, by F. D. Ezekiel. (57—SA-50)

Work Capacities of Energy Storage Systems on Basis of Unit Weight and Unit Volume, by L. V. Kline, S. M. Marco, and W. L. Starkey. (57—SA-7)

Resistance to Rolling and Sliding, by A. C. Dunk and A. S. Hall, Jr. (57—SA-9)

Comparison of Semi-Empirical Solutions for Crack Propagation With Experiments, by J. Frisch. (57—SA-12)

Analysis of Residual Stress in Ground Surfaces of High-Temperature Alloys, by R. D. Halverstadt. (57—SA-62)

General Design Considerations for Smaller Gas Turbines, by W. T. Von Der Nuell. (57—F-13)

Formulations for the Thermodynamic Properties of Steam and Water, by H. C. Schnackel. (57—A-105)

The Formulation of Steam Properties for Digital Computer Application, by W. G. Steltz and G. J. Silvestri. (57—A-109)

ASME Papers Order Form

Copies of ASME technical papers digested this month are available in pamphlet form. Please order only by paper *number;* otherwise the order will be returned. Orders should be addressed to the ASME Order Department, 29 W. 39th St., New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 to members; $4 to nonmembers.

Note: No digests are made of ASME papers published in full or condensed form in other sections of MECHANICAL ENGINEERING.

Copies of all ASME publications are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th Street, New York, N. Y.

ASME Transactions and the *Journal of Applied Mechanics* are on file in the main public libraries of large industrial cities and in the technical libraries of engineering colleges having ASME Student Branches.

ASME Order Department
29 W. 39th St.
New York 18, N. Y.

Date.....

Please send me the papers indicated by the following circled numbers:

57—A-64	57—A-287	58—GTP-15
57—A-65	57—A-288	58—GTP-16
57—A-78	57—A-290	58—GTP-17
57—A-80	57—A-291	58—GTP-18
57—A-97	57—A-292	58—GTP-19
57—A-104	57—A-293	58—GTP-20
57—A-106	57—A-294	58—GTP-21
57—A-124	57—A-295	58—WDI-1
57—A-134	57—A-296	58—WDI-2
57—A-158	57—A-297	58—MGT-1
57—A-169	57—A-298	58—MGT-2
57—A-171	58—GTP-1	58—MGT-3
57—A-191	58—GTP-2	58—MGT-4
57—A-198	58—GTP-4	58—MGT-6
57—A-207	58—GTP-5	58—MGT-7
57—A-210	58—GTP-6	58—AV-9
57—A-216	58—GTP-7	58—AV-10
57—A-224	58—GTP-9	58—AV-16
57—A-246	58—GTP-10	58—AV-17
57—A-275	58—GTP-11	58—AV-18
57—A-277	58—GTP-12	58—AV-21
57—A-285	58—GTP-13	58—AV-26
	58—GTP-14	58—AV-28

Name.....

Address.....

City..... State.....

☐ Remittance enclosed ☐ Bill me

☐ ASME Mem. ☐ Nonmem.

Includes Letters from Readers on Miscellaneous Subjects

COMMENTS ON PAPERS

The Engineering Shortage

To the Editor

GEORGE R. WADLEIGH's interesting letter in MECHANICAL ENGINEERING, March, 1958, page 120, on the engineering shortage and the I.Q. level needed in engineering, raises an important point. He classifies the adolescent population into one per cent, very superior; 11 per cent, superior; 18 per cent, high average; and so on, and suggests that all 30 per cent should be considered as possible engineers.

An I.Q. is an imperfect measure of intelligence, but high intelligence itself is essential for true engineering work. There is no doubt in my own mind that professional engineers must come from the upper ten per cent of the population.

There is nothing undemocratic in the equivalence of professional groups and an intellectual elite, provided students from all economic levels of the population have equal opportunity for advanced education. In fact, the two are inseparable if our democratic society is to survive. Pressure in the direction Mr. Wadleigh proposes will be strong and the safety of all of us depends upon deflecting it into helping people choose realistic goals.

The lower group labeled high average should be guided into technician and engineering-aide jobs if their interests run toward engineering. Mr. Wadleigh's comments on his ability in mathematics are not relevant as his letter contains impressive evidence of his high ability and intelligence.

D. C. Drucker.[1]

Creativity in Engineering

To the Editor

CONGRATULATIONS on the articles "Developing Creativity in Engineering," by D. G. Taylor and R. C. Jordan, and also "Characteristics of the Creative Engineer," by G. J. Spencer, published in MECHANICAL ENGINEERING, February, 1958, pages 74–75 and 78–80.

These articles will be very helpful, I am sure. In my experience, engineers are often unduly modest sometimes to their own detriment. They have far more creative ability than they realize.

Furthermore, they know how to present their ideas effectively, either to their superiors or to people outside of their company.

Unfortunately, the belief that they cannot write reports holds some engineers back. I think there are several reasons for this misplaced modesty. In college, engineers have associated with large number of students who think they will become engineers. Many of them do not, but those who thrive on competition forget how much they have grown. Then again the pressure of work means that successes are taken for granted, but slips or mistakes are magnified.

Some simple statistics show that engineers, as a group, turn out a prodigious quantity of writing. With a few references, one can show the extraordinarily high quality of it.

W. A. Sylvester.[2]

Correction—Compressed Water

IN the paper by T. C. Tsu[3] and D. T. Beecher,[4] "Thermodynamic Properties of Compressed Water," published in MECHANICAL ENGINEERING, October, 1957, pp. 939–943, there is one inaccurate statement. The authors wish to take this opportunity to revise that statement, and request that you publish this letter.

Under example F on p. 941 of the subject paper, a problem on discharge of water from a pressure vessel was discussed. Water at 5000 psia and 580 F discharges to atmospheric pressure. It is desired to determine the state of the initial escaping fluid after it has leaked outside the vessel. In the published paper it was stated that "..... its enthalpy after escape is equal to its internal energy before escape." This statement should be revised to read "its total enthalpy (or stagnation enthalpy) after escape is equal to its enthalpy before escape." The solution then proceeds as follows:

The initial state is $p_1 = 5000$ psia, $t_1 = 580$ F, $v_1 = 0.021364$ cu ft/lb, and $h_1 = 580.25$ Btu/lb. After the discharge, the final pressure is $p_2 = 14.696$ psia, and the total enthalpy is $H_2 = h_1 = 580.25$ Btu/lb, where H denotes the total enthalpy and h denotes the static enthalpy. By definition, $H_2 = h_2 + U_2^2/2gJ$, where U_2 is the velocity of the escaping fluid. U_2 would be equal to the local velocity of sound and is estimated to be 870 ft/sec. Therefore

$$h_2 = 580.25 - \frac{(870)^2}{(2)(32.174)(778.16)} = 565.11 \text{ Btu/lb}$$

Knowledge of p_2 and h_2 determines state 2, which gives a steam quality of 0.397, $v_2 = 10.64$ cu ft/lb, and $t_2 = 212$ F.

Having thus obtained state 2, one then checks back to see whether or not the estimated acoustic velocity is consistent. At state 2, the value for the isentropic exponent k is found to be 1.044. The acoustic velocity is

$$\sqrt{kgp_2v_2} = \sqrt{(1.044)(32.174)(14.696 \times 144)(10.64)} = 869.7 \text{ ft/sec}$$

which is very close to the assumed value of 870 ft/sec. Hence the solution is accepted as correct.

The correct solution gives steam quality = 0.397 and $v_2 = 10.64$ cu ft/lb. The previously published values were:

[1] Chairman, Division of Engineering, Brown University, Providence, R. I., technical co-editor, *Journal of Applied Mechanics*. Mem. ASME.

[2] Editor, technical publications, Sales Technical Division, The Standard Oil Company (Ohio), Cleveland, Ohio.

[3] Advisory Engineer, Westinghouse Research Laboratories, Churchill Borough, Pittsburgh, Pa. Mem. ASME.

[4] Research Engineer, Westinghouse Research Laboratories, Churchill Borough, Pittsburgh, Pa.

steam quality = 0.392 and v_2 = 10.52 cu ft/lb. Although the differences are small, the procedure given in this letter is more rigorous.

T. C. Tsu and D. T. Beecher.

Gyroscopes

Comment by S. L. Burgwin[5]

THE author of this paper[6] is to be complimented upon presenting a simple picture of the functions, requirements, and limitations of gyroscopes as applied to inertial navigators.

The gyro requirement of distinguishing importance in inertial applications, as the author has pointed out, is low drift rate. Thus factors causing gyro drift errors and their control are of first importance in gyros for inertial navigation. The author has touched briefly on some of these factors; friction of gimbal bearings, mass shift, acceleration, and nonacceleration sensitive torques. He has referred to two patents assigned to North American as examples of how the effects of gimbal friction and anisoelastic torques can be minimized and controlled.

One important area which he has not touched on is the extensive work carried on at M.I.T., at Minneapolis-Honeywell, and at other organizations in minimizing the factors causing gyro drift errors. Those readers interested in penetrating more deeply into the causes and control of gyro drift errors will find considerable unclassified literature dealing with this subject.

The following list of papers presents a partial, but by no means complete, bibliography:

1 "Inertial Gyro Pivot-and-Jewel Suspension," Gyro Lab Report GL-211 Instrumental Laboratory M.I.T.

2 "Basic Equations of Gyro Unit Compliance," Gyro Lab Report GL-154 Instrumentation Laboratory M.I.T.

3 "Gyroscope Unbalance Torques Resulting from Static, Linear Compliances," Instrumentation Laboratory Report E-508 M.I.T.

4 "A Technical Discussion of Gyro Drift Rate," Minneapolis-Honeywell Aero Document U-ED-9714, May 14, 1954.

5 "Effect of Periodic Rotations on Gyroscopic Sensing Devices," Minneapolis-Honeywell Aero Document R-ED 9770, January 25, 1957.

6 "HIG-6 Gyro Descriptive Material," Minneapolis-Honeywell Aero Document U-ED-828, January 27, 1957.

7 "Versatility of Floated-Type Rate Integrating Gyroscopes in Systems Applications," by J. W. Lower, IRE Convention Record 1955, Part V, Aeronautical and Navigational Electronics.

8 "Floated Gyro Anisoelastic Torques Due to Vibration and Linear Acceleration," Floated Gyro Application Note No. 7, Minneapolis-Honeywell Aero Document U-ED 9749.

9 "Vibration and Linear Acceleration Effects on Floated Gyros," Floated Gyro Application Note No. 8, Minneapolis-Honeywell Aero Document U-ED-9749.

10 "Calculations of Gyro Drift Rate Resulting from External Accelerations," Minneapolis-Honeywell Aero Document R-ED 9746.

Comment by Walter Wrigley[7] and W. G. Denhard[8]

WE ARE pleased to see the author's step into the area of an unclassified presentation covering the general field of gyroscopic instruments for inertial navigation.

His comments regarding the general accuracies required of gyroscopic instruments for various classes of applications are quite in order, and as he commented, the tighter requirements in terms of drift have in general tied in with them the stringent requirement of open loop or unreferenced operation. In addition, in the inertial navigator (as in the effectively closed loop gyrocompass operation) the time of operation may be measured in hours rather than seconds or minutes as in the case of fire control and the gyrohorizon, for example.

A gyroscope for inertial navigation must include a precisely balanced framework in which the spinning wheel or gyroscopic element is mounted. The problem in simplest terms becomes one of providing this precisely balanced framework with its balance held constant (or calibrated) at fantastically low levels of uncertainty. Since the gyro is tied in to a navigation system with signal pick-off devices requiring some small amount of precession of the gyroscopic element, there is a requirement of equally small friction levels on the bearings of the precession axis.

Since the discussion centers itself primarily on the single-degree-of-freedom instrument, it will be worth while to look at a pictorial view of a floated single-degree-of-freedom integrating gyroscope as shown in Fig. 1. This type of instrument, with development extending over a period of years, has been pursued with measurable success by the M.I.T. Instrumentation Laboratory as well as by many other organizations.

The figure shows the defined axes of the instrument:

The Output Axis (OA) being the single axis about which precession can take place and sometimes called the Precession Axis.

The Spin Axis (SA) being the shaft axis for the gyrowheel.

The Spin Reference Axis (SRA) being the position of the Spin Axis when the precession is zero; i.e., the Gimbal Angle (A_{gim_1}) = 0.

The Input Axis (IA) being that axis about which positive angular velocity input (in vector terminology) will cause the gyroscopic element, or gyrowheel, to precess in such a direction as to generate a clockwise gimbal angle about the Output Axis; this being associated with the right-hand screw rule.

Also shown in the figure are the damping annulus, the signal element called a signal generator microsyn and a biasing or correcting element called a torque generator microsyn. The gimbal bearings appear at either end of the Output or Precession Axis.

Please note that the gyrowheel is sealed in a can called the float, from whence the unit is called a floated gyroscope.

The author in his paper commented that the Input Axis is an axis in space. We would like to add that this axis is always associated with a controlled axis of a navigation platform (though often through a complex of spherical co-ordinates).

With regard to his comments regarding the association of gyrodynamics with the servo system, we would like to add a loud "Amen." For freedom from parasitic oscillations and stability, generally, the servo loop must contain damping in proportion to its stiffness or rigidity. If this can be provided by the gyro internal damping, inherent in the integrating gyro, the chances of suitable servo operation are improved and easier to accomplish.

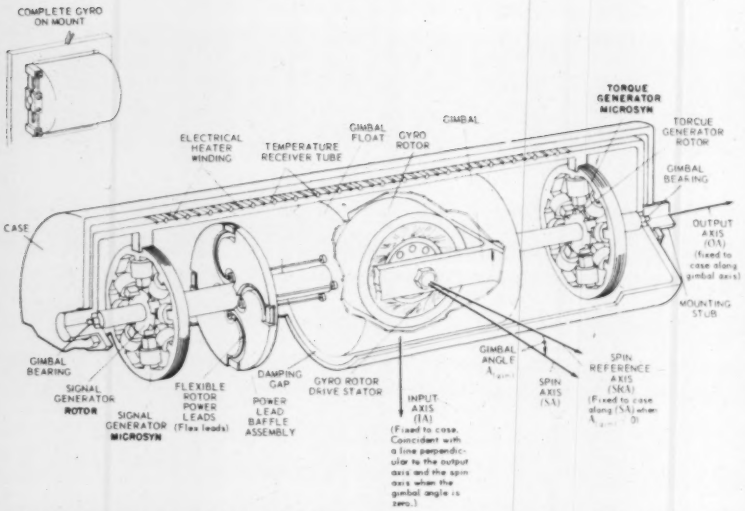
Because of interaction between the two axes of freedom of a two-degree-of-freedom gyroscope, the problems in it are

[5] Gyro staff engineer, Inertial Gyro Section, Aeronautical Division, Minneapolis-Honeywell Regulator Company, St. Petersburg, Fla.

[6] "Gyroscopes for Inertial Navigation," by J. M. Slater, MECHANICAL ENGINEERING, vol. 79, September, 1957, pp. 832–835, 857, condensed from ASME Paper No. 57—SA-39.

[7] Professor, aeronautical engineering, M.I.T. Educational Director, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

[8] Assistant director, navigational gyros, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. Mem. ASME.


COMPLETE GYRO ON MOUNT
ELECTRICAL HEATER WINDING
TEMPERATURE RECEIVER TUBE
GIMBAL FLOAT
GYRO ROTOR
GIMBAL
TORQUE GENERATOR MICROSYN
TORQUE GENERATOR ROTOR
GIMBAL BEARING
CASE
OUTPUT AXIS (OA) (Fixed to case along gimbal axis)
MOUNTING STUB
GIMBAL BEARING
SIGNAL GENERATOR ROTOR
SIGNAL GENERATOR MICROSYN
FLEXIBLE ROTOR POWER LEADS (Flex leads)
DAMPING GAP
POWER LEAD BAFFLE ASSEMBLY
GYRO ROTOR DRIVE STATOR
INPUT AXIS (IA) (Fixed to case. Coincident with a line perpendicular to the output axis and the spin axis when the gimbal angle is zero.)
GIMBAL ANGLE
SPIN AXIS (SA)
SPIN REFERENCE AXIS (SRA) (Fixed to case along (SA) when

Pictorial schematic of the single-degree-of-freedom floated integrating gyro unit.

more than twice the complexity found in the single-degree-of-freedom instrument, and major interest in the gyroscope field lies in the single-degree-of-freedom instrument. The comparison in complexity between single-degree-of-freedom and two-degree-of-freedom instruments may be likened to the contrast between planar or two-dimensional and three-dimensional tic-tac-toe.

The comments regarding preference for moving coil transducers over moving iron types are not sufficient to cover this large area. Good performance does not come without effort. The geometry of moving iron transducers is critical, but the coil support and leads for the moving coil type are equally critical. Considerable support can be had for both types.

The author's comment that properly designed gas bearings have negligible friction bypasses the difficulty of obtaining true rigidity, high natural frequency, and "proper" geometry.

With Air Force support, our laboratory has engaged in a program of centrifuge testing so obviously we disagree with the thought that there are critical limitations to this type of testing.

As to his comments on good gyro design requiring stable materials and extreme rigidity, they tie in directly with our earlier comments regarding critical balance, and we can only add re-emphasis to his remarks.

With respect to the proper contact angle for isoelastic operation, a paper on this subject is under preparation for presentation at a later meeting, but basically we do not agree experimentally with his 35-deg contact angle.

Authors' Closure

The author wishes to thank Mr. Burgwin, Professor Wrigley, and Mr. Denhard for commenting upon the paper.

Journal articles have appeared, pertinent to the matters to which Mr. Burgwin calls attention, after the manuscript left the author's hands. One would cite the papers of Draper et al.[9] and Goodman et al.[10] as of special relevance to the precision gyroscope field.

Certain points raised by Professor Wrigley and Mr. Denhard will be taken up briefly.

In regard to the association of gyrodynamics with the platform-stabilizing servo system, the recent papers of Cannon and Chandler,[11,12] which include treatments of systems using undamped gyroscopes, supplement the Draper et al.[9] paper describing systems based on use of damped gyroscopes.

It is conceded that considerable support can be found for both moving-coil and moving-iron types of transducers —also that lead-in wires are a perennial nuisance. In applications wherein precision *variable* control torques must be applied to the gyroscope, to produce precession rates from zero to 15 deg per hr or more, the moving-coil type of torquer appears to be displacing the moving-iron type.

Obtaining rigidity of structure in gas and liquid bearings is not difficult. The co-operating parts of the bearings are relatively simple spherical or cylindrical structures which are large compared, for example, with pivots and jewels, torsion wires or fulcrum-tape arrangements. The author is not aware of any difficulty whatever in obtaining high natural frequency. If a gas or liquid bearing has the required area and supply pressure to support the design load, it inevitably will have a very small compliance. Assuming a typical working gap of 0.0005 in., and 5-lb load-carrying capacity, the compliance is 0.0001 in. per lb. As for obtaining proper geometry, experience indicates that tolerances are significantly less critical than (for example) those to be held in the gyroscope spin-bearing assembly.

As for centrifuges, an example of the sort of limitation to which allusion was made is the testing of isoelastic properties of gyroscopes by application of accelerations in various fixed directions relative to the gyroscope axes. The precision centrifuge project referred to by Professor Wrigley and Mr. Denhard is certainly the most advanced effort of its kind, and progress is being followed with great interest.

As regards the ball-bearing contact angle for isoelasticity: The 35-deg angle is that calculated for the bearings alone (inner and outer race members, and balls). The anisoelastic compliance of shafts and other members of the gimbal assembly may dictate selection of a smaller angle, in order to achieve a net isoelasticity of the assembly as a whole.

In conclusion, the author would like to express two hopes. First, that security regulations may be modified to allow publication of a more quantitative analysis of precision gyroscopes and their problems than is permissible at present. Second, that organizations which are experienced in the field will be active in publishing their work, in generally accessible publications, as an aid to progress of the art. At present, the technical literature does not reflect the importance and magnitude of the inertial component art.

J. M. Slater.[13]

[9] C. S. Draper, W. Wrigley, L. R. Grohe, "The Floating Integrating Gyro and Its Application to Geometrical Stabilization Problems Moving Base," *Aeronautical Engineering Review*, 15, no. 6, June, 1956, p. 46.

[10] L. Goodman and A. R. Robinson, "The... Floated Gyroscopes," ASME Paper No. 57—APM-31 (to be published in the *Journal of Applied Mechanics*).

[11] R. H. Cannon, Jr., "Kinematic Drift of Single-Axis Gyroscopes," ASME Paper No. 57—A-72 (to be published in the *Journal of Applied Mechanics*).

[12] R. H. Cannon, Jr., and D. P. Chandler, "Stable Platforms for High-Performance Aircraft," presented at Annual Summer Meeting of the Institute of Aeronautical Sciences, Los Angeles, Calif., June 19, 1957. *Aeronautical Engineering Review*, vol. 16, no. 12, December, 1957, p. 42.

[13] Autonetics Division, North American Aviation, Inc., Downey, Calif.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

America as a Civilization

America as a Civilization.
By Max Lerner. Simon & Schuster, New York, N. Y., 1957. Cloth, 6 × 9 in., references, index, 1036 pp., $10.

Reviewed by George A. Stetson[1]

ANYONE who completes the reading of Max Lerner's 1000-page book, "America as a Civilization," will lay it down with an almost frustrating realization of the number and complexity of the conditions and forces involved in charting the course of future social, economic, and cultural developments. This book appears at a time when perspective, perception, and a sense of proportion are desperately needed. Our collective knowledge is vast. But most of us are specialists in some narrow field of the total expanse of it. In the formation of value judgments, it is difficult for the specialist to curb the intellectual arrogance which interprets issues and solutions in the frame of reference of his specialty, or for him not to dismiss them as being unworthy of his interest because he is ignorant or impoverished in fields other than his own. Few if any persons can today aspire as Bacon did "to take all knowledge to be my province." But there remains no excuse for educated persons to make no effort to discover what other specialists are thinking about, or to give some breadth as well as depth to their views on questions that vitally affect the general-welfare. From this point of view engineers could be better and more useful citizens if they were more familiar with some of the broad areas of our civilization of which Max Lerner offers a convenient panorama.

Among the virtues of this book is its readability. The style is fluent as might be expected of one who has been a newspaper columnist, lecturer, and commentator. One may read without reference to the dictionary.

Max Lerner begins his book with a discussion of the American heritage. He then asks and answers in the affirmative the question, Is there an American Civilization?—an effort, he says "to evoke the American spirit by evoking its past, and to interpret the American tradition as a living heritage with changing meanings." He then takes a "look at the central idea of the book—the idea that America is best seen as a total civilization pattern—and grapples with some of the ideas involved in it." In the third chapter he investigates "two basic ingredients of American civilization, the continent itself and the people who live on it." What will be read by engineers with the greatest attention is the culture of Science and the Machine. "Tracing the series of industrial revolutions that have given America the sense of being in a 'permanent revolution,' we examine the technician and pose the probably insoluble question of whether he (and the scientist too) can be 'neutral' when faced with the choice of what shall be done with his science and machines."

Examination is made also of the worker (the factory as a society) and finally of the consumer with the array of commodities at his disposal and the effect of plenty on American thinking.

The fifth chapter, "Capitalist Economy and Business Civilization," explores the evolution of the corporation as the "type form of American business enterprise," the "role of labor and trade unions in the American economy," and draws "a profile of the changes in the pattern of economic and governmental relations in America, which defies easy labeling as either 'capitalism' or 'Americanism' but is a unique amalgam of both."

Chapter 6, "The Political System," deals with "the curious but effective ways that Americans have of governing—and misgoverning—themselves"; and chapter 7, with "Class and Status in America," in which attention is directed to ruling groups, old and new, "complex emerging forms of the middle classes," to workers, and to minority groups. In chapter 8, the author traces "what happens to the American in the course of his life cycle from birth to death." Considering "Character and Society," chapter 9, he deals with themes "relating in someway to the wholeness and fragmentation of American life, to the codes by which Americans live or which they break, and to the relations between the structure of American society and the lineaments of the American character."

"Belief and Opinion," chapter 10, looks at religion, social thought, the school system, journalism and the press, and technological changes that have produced a revolution in the opinion industries, restricting itself to "opinion and belief aspects of the Big Media."

Forms Americans use to express their imaginative and artistic life, and the new modes of communication and recreation that tie regions and classes together in the "Big Audience of the Big Media," are examined in chapter 11. And finally, we come in chapter 12 to an over-all view of America's place in the frame of world power, asking what kind of power it embodies and how much promise or menace it holds for the world.

There is no doubt in this reviewer's mind that Max Lerner, after his objective analysis of the good and the bad of American civilization, with all its complexities and contradictions, finds that it is real and that it is dynamic. "There is still in the American potential," he notes optimistically in his concluding paragraph, "the plastic strength that has shaped a great civilization, and it shows itself in unexpected ways, at unpredictable moments, and in disguises that require some imaginative understanding to unveil. What Emerson said a century ago I would still hold to: 'We think our civilization is near its meridian, but we are yet only at the cockcrowing and the morning star.' "

One does not need to accept without question the opinions expressed by the author of this book, but he should read it with an open mind. If his own opinions are broadened and deepened thereby, his time will not have been wasted and his outlook on American civilization will have been enriched.

[1] Editor-Emeritus, ASME. Fellow ASME.

BOOKS RECEIVED IN LIBRARY

Brittle Behavior of Engineering Structures
By E. R. Parker. 1957, John Wiley and Sons, Inc., New York, N. Y. 323 p., 9¼ in., bound. $6. Prompted by the failures in welded steel merchant ships in 1942–1943, research in this field was instituted and widened to include all steel plate structures. This volume summarizes the available information, covering the following: fundamental properties and fracture theories; test methods and interpretation of results; influence of chemical composition and manufacturing practice; effects of welding composition variations; residual stresses; design aspects; and reports on individual service failures. This study was prepared for the Ship Structure Committee under the general direction of the Committee on Ship Steel of the National Research Council.

The Demand and Supply of Scientific Personnel
By D. M. Blank and G. J. Stigler. 1957, National Bureau of Economic Research, New York, N. Y. 200 p., 6¼ × 9¼ in., bound. $4. This important study offers evidence that, contrary to many previously published reports, there is no shortage of engineers in the United States. The study consists of five chapters dealing, respectively, with the growth of the technological professions; demand and supply; factors influencing the demand for engineers and chemists; the supply of engineers; and supply and demand for mathematicians and physicists. A considerable amount of statistical data are included in appendixes.

Designing for Production
By E. N. Baldwin and B. W. Niebel. 1957, Richard D. Irwin, Inc., Homewood, Ill. 645 p., 6 × 9¼ in., bound. $8.40. Primarily a textbook for engineering and technical students presenting fundamentals underlying the design and manufacture of a product that will be functionally sound, marketable, and profitable. Ferrous, nonferrous, plastics, rubber, and synthetic rubber materials are described from the designers' viewpoint. Manufacturing information includes metal forming and shaping, metal cutting, joining processes, finishing processes, and packaging.

Fatigue Durability of Carburized Steel
Published 1957 by The American Society for Metals, Cleveland, Ohio. 123 p., 6 × 9¼ in., bound. $4. A group of three papers as follows: Effect of surface condition on the fatigue resistance of hardened steel; residual stresses in carburized steel; summarized results of an extensive series of tests on fatigue durability of carburized steels. A summary of the over-all research is included and there is a bibliography.

Heat Transfer and Fluid Mechanics Institute, 1957
Preprints of Papers. Published 1957 by Stanford University Press, Stanford, Calif. 439 p., 8½ × 11 in., paper. $8.50. A wide range of subject matter is covered by the 21 papers included in this volume: shock waves; instability of bubbles; liquid drop action on surfaces; boundary layer problems in fluid flow; heat transfer under various conditions; flames and ignition; chemical kinetics of air at high temperatures; mass transfer by sublimation; several specialized treatments of turbulence and other aspects of fluid flow.

Hutte
Vol. IV A, Electrotechnik: Part A, Starkstromtechnik; Lichttechnik. 28th edition, 1957. Wilhelm Ernst & Sohn, Berlin, Germany. 946 p., 4¾ × 7¼ in., bound. DM 49.00. This well-known, standard reference work, covering the whole field of engineering, has now been expanded to nine volumes. The present volume comprises a comprehensive treatment of heavy-current technology: operation, selection, and testing of electrical ma-

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting Feb. 28, 1958, and approved by the Board on May 5, 1958.)

Annulment of Cases

The following cases are annulled:

Case No.	Reasons for Annulment
905	Replaced by Case No. 1202
1211	Rules for nodular iron now included in Section VIII
1216	Specification A-278 has been modified making Case no longer necessary

Case No. 1251

(Special Ruling)

(Carbon Steel Flanges of 55000 Ultimate Strength)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII to use forged or rolled steel pipe flanges in the range of −20 to 650 F which meet the following requirements as to chemical and mechanical properties:

CHEMICAL PROPERTIES	PER CENT
Carbon	0.20 max
Manganese	0.90 max
Phosphorus	0.05 max
Sulfur	0.05 max
Silicon	0.35 max

MECHANICAL PROPERTIES	
Tensile strength, min. psi	55,000
Yield point, min. psi	30,000
Elongation in 2 in., min. per cent	22
Reduction of area, min. per cent	35

Reply: (1) It is the opinion of the Committee that forged or rolled steel pipe flanges as described in the Inquiry may be used in the range of −20 to 650 F in welded construction conforming in other respects to the requirements of Section VIII. They shall be stamped with the number assigned to this Case in lieu of a specification and grade number.

(2) The pressure-temperature ratings for ASA flanges of this material shall be taken as 90 per cent of the values given for carbon steel in ASA B16.5-1957.

(3) For flanges of special design, the allowable stress shall be 13750 psi.

Case No. 1252

(Special Ruling)

(Use of Modified Type TP321 Austenitic Steel for Tubes)

Inquiry: May an austenitic steel that is a modification of Type TP321 (TP-321H) and having the following chemical requirements be used for high-temperature service such as the construction of superheater and reheater tubes in accordance with Specification SA-213, and what

chines; transformers and induction coils; power transmission and distribution; current regulators; electric heating; low and high-voltage switching; as well as such generalized topics as the materials involved, standards, and symbols. The volume also covers the theory and practice of illumination. A detailed, 30-page index is provided.

Light Scattering by Small Particles
By H. C. van de Hulst. 1957, John Wiley & Sons, Inc., New York, N. Y. 470 p., $5^3/_4 \times 9^1/_4$ in., bound. $12. An authoritative explanation of available data concerning phenomena of importance in many fields of science. For simplicity the author restricts himself to dealing with single scattering by independent particles with the assumption that the scattered light retains the same frequency as the incident light. Usable graphs and numerical results are provided throughout the book, particularly in part 2 which covers a great variety of special particles, and part 3 which demonstrates selected applications in physics and chemistry.

Linear Programming; An Explanation of the Simplex Algorithm
By Dakota U. Greenwald. 1957, The Ronald Press Company, New York, N. Y. 75 pp., $5^1/_4 \times 8^1/_4$ in., bound. $3. Linear programming may be described as a mathematical technique for determining the most effective course of action when a situation is governed by many known variables and conditions. In this small book a simplified technique is presented which is applicable to a great many engineering and management problems. A number of concrete examples, chiefly from production engineering, are here worked out, and mention is made of other books, on refinery problems for example, for which this book is a useful introduction.

LIBRARY SERVICES

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Machine Literature Searching
By James W. Perry and others. 1956, Interscience Publishers, Inc., New York, N. Y. 162 p., $7^3/_4 \times 10^3/_4$ in., bound. $4. Although the primary concern of this book is machine literature searching, much general information is included on such subjects as problems in indexing, collection of terminology, code development, organization of semantic units, designing of information retrieval systems, and machine language. The appendix constitutes an excellent bibliography in this and related fields.

Platin
Gmelins Handbuch der Anorganischen Chemie, System-Nummer 68, Teil D. Eighth Edition, 1957. Verlag Chemie, Weinheim, Germany. 638 p., $6^3/_4 \times 10$ in., bound. $90. A concise but thorough description of some 2880 platinum complex compounds with neutral ligands (attached atoms or groups), together with the extensive literature references customarily provided in the volumes of this important series. A detailed introduction deals with the arrangement of the material, the nomenclature, and formulas; provides summaries of the more important ligands, of the general properties of platinum complex compounds, and of the Russian literature concerning them; and gives a general treatment of the theoretical aspects of the field.

maximum stress values may be used in design?

TABLE I CHEMICAL REQUIREMENTS

	PER CENT
Carbon	0.04/0.10
Manganese	2.00 max
Phosphorus	0.030 max
Sulfur	0.030 max
Silicon	0.75 max
Nickel	9.00/13.00
Chromium	17.00/20.00
Titanium	[a]

[a] Modified Type TP321 (TP321H) shall have a titanium content of not less than four times the carbon content and not more than 0.60 per cent.

Reply: It is the opinion of the Committee that an austenitic steel having the chemical composition given in the Inquiry may be used for the construction of superheater and reheater tubes provided:

(1) The tubes otherwise meet the requirements of Specification SA-213, except for the heat treatment and marking.

(2) All materials shall be furnished in the heat-treated condition. The heat treatment shall be at a minimum temperature of 2000 F. As evidence that the material has received this treatment it shall exhibit a grain size of 7 or coarser as determined in accordance with ASTM Designation: E 19.

(a) The number of grain size determinations shall be the same as the number of samples required for the flattening test under Section 14(d) of SA-213.

(3) In addition to the marking required in Section 21 of SA-213 they shall include heat number and heat treatment lot identification.

(4) The maximum allowable stress values at the temperatures indicated are those listed in Table P-7 in Section I and Table UHA-23 in Section VIII of the Code for Grade TP321 in SA-213.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

AS NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Power Boilers, 1956

PAR. P-23(a) Redefine C as follows:

C = allowance for threading and minimum structural stability, in.

PAR. P-23(b) Revise to read:

The values of C do not include any allowance for corrosion and/or erosion, and additional thickness should be provided where they are expected. The allowances for threading and minimum structural stability are not intended to provide for conditions of misapplied external loads or for mechanical abuse.

The value of C used in the formula shall be not less than that given for the respective materials in the following list:

TYPE OF PIPE	PIPE SIZE RANGE	VALUE OF C[a]
Steel or wrought iron, threaded	$^3/_4$ in. and smaller	0.065
Steel or wrought iron, plain end	$^3/_4$ in. and smaller	0.065
Steel or wrought iron, threaded	1 in. and larger	Depth of thread h[a]
Steel or wrought iron, plain end	1 in. to $3^1/_2$ in., incl.	0.065
Steel or wrought iron, plain end	4 in. and larger	0.000

Revise the footnotes as follows:

[2] Revise the words "less than" in line 2 to "no greater than."

[3] Delete $n = 14$ and $h = 0.0571$.

PAR. P-27(f) Revise the reference to ASA B16.5-1953 to read "ASA B16.5-1957."

PAR. P-203 Reletter present Subpar. (e) to read (f) and add new Subpar. (e) to read:

(e) For unflanged heads, the maximum distance between the inner surface of the shell and the center of braces, or rivets attaching crow feet of braces, shall be not more than $^1/_2\ p$ plus 2 in.

p shall be determined from Par. P-199 using 135 for the value of C.

PAR. P-299(e) In the last sentence revise the reference to ASA B16.5-1953 to read "ASA B16.5-1957."

TABLE P-15 Delete all Class B ratings and their corresponding pressures.

Revise footnote 1 to read "derived from Tables 2 to 8 of ASA B16.5-1957."

Delete footnote 3 in its entirety.

TABLE A-5 Revise the note to read "Values obtained from Table 9 and Notes to this Table in ASA B16.5-1957 may be used for the requirements of Table A-5."

TABLE A-6 Revise the statement to read "Values obtained from Tables 13 to 33 inclusive, and Notes to these Tables in ASA B16.5-1957 may be used for the requirements of Table A-6."

TABLE A-9 Revise the note to read "Values obtained from Tables 2 to 8, inclusive, and Notes to these Tables, in ASA B16.5-1957 may be used for the requirements of Table A-9."

TABLE A-10 Revise the note to read "Values obtained from Table 10, and Notes to that Table, in ASA B16.5-1957 may be used for the requirements of Table A-10."

Material Specifications, 1956

The Boiler and Pressure Vessel Committee has approved adding to Section II the following revisions to specifications and new specifications.

FERROUS (REVISED)

Ferritic Castings and Forgings

SA-105-57T, SA-181-57T, SA-182-57T, SA-216-57T, SA-217-57, SA-266-57, SA-278-57, SA-306-57T, SA-336-57T, SA-350-57, SA-352-57T

Ferritic Plates

SA-6-57T, SA-20-57T, SA-201-57T, SA-204-57, SA-212-57aT, SA-285-57T, SA-300-57, SA-387-57T

Ferritic Tubular Products

SA-53-57T, SA-135-57T, SA-192-57T, SA-226-57T, SA-333-57T

Stainless Steels

SA-182-57T, SA-193-57T, SA-213-57T, SA-240-57, SA-249-57T, SA-268-57, SA-312-57T, SA-320-57T, SA-351-57T

FERROUS (NEW)

SA-410-57T Chromium-Copper Nickel-Aluminum Alloy Steel Plates for Pressure Vessels

SA-414-57T Carbon Steel Sheets of Flange and Firebox Qualities

NONFERROUS (REVISED)

SB-13-57

SB-42-57

SB-43-57

SB-75-57, except with the deletion of the following words in the first sentence of Section 6(a) "and grain size prescribed in Table II."

SB-111-57, except with addition of the following words to the Note under Section 4 "in which case the provisions for grain size in Section 7(a) do not apply."

SB-211-57T, including only alloys GS11A-T6, CG42A-T4 and CS41A-T6. Delete from Section 2(4) "whether yield strength tests are required (Section 7)."

Delete that portion of Section 7 which reads: "Requirements for yield strength are included for such applications as pressure vessels but for most applications involving the use of alloys 990A, 996A and GR-20A yield strength is not important. For these alloys yield strength need not be determined unless specifically indicated in the contract or purchase order."

Delete footnote *b* of Table II.

SB-234-57T except with the deletion of Alloy GS11C.

SB-247-57T approved only for alloys M1A-F, CS41A-T4 and T6, GS11A-T6 and GS11B-T6.

SB-260-56T except delete all references to alloy BMg and note under title to read: "Based on B 260-56T."

NONFERROUS (NEW)

SB-209-57 approved only for alloys 990A, 996A, G1A, GM40A, GM41A, GM51A, GR20A, GR40A, GS11A, Clad GS11A, M1A, Clad M1A, MG11A, Clad MG11A

Delete Section 2(4) which reads: "Whether yield strength tests are required (Section 7)."

Delete the portion of Section 7 which reads "Requirements for yield strength are included for such applications as pressure vessels, but for most applications involving the use of alloys 990A, 996A, G1A, G1B, GM40A, GM41A, GM51A, GR20A, GR40A, M1A, Clad M1A, MG11A and Clad MG11A, yield strength is not important. For these alloys, yield strength need not be determined unless specifically indicated in the contract or purchase order."

Delete footnote *b* of Table II which reads: "Yield strength to be determined only when specified in the contract or purchase order."

In Table II, delete materials thinner than 0.051 in. Also delete requirements for 990A-H16 and H-18, G1A-H36 and H-38, GM40A-H36, GR20A-H-36 and H38, GR40A-H36 and H38, GS11A-O, Clad GS11A-O, M1A-H16 and H18, MG11A-H36 and H38.

SB-210-57T approved only for alloys 996A-0, H112 and H14, GS10A-T6, GS11A-T4 and T6, M1A-0, H14 and H18, Clad M1A-0, H112, H14 and H18, and GR40A-0 and H34.

Delete Section 2(4) which reads "Whether yield strength tests are required (Section 7)."

Delete that portion of Section 7 which reads: "Requirements for yield strength are included for such applications as pressure vessels, but for most applications involving the use of alloys 990A, 996A, GR20A, M1A, Clad M1A, and MG11A, yield strength is not important. For these alloys, yield strength need not be determined unless specifically indicated in the contract or purchase order."

Delete footnote *c* of Table II which reads: "Yield strength to be determined only when specified in the contract or purchase order."

SB-221-57T approved only for alloys CG42A-T4, GS11A-T6, GM51A-0, H112 and H311, and GR40A-0 and H112.

Delete Section 2(4) which reads: "Whether yield strength tests are required (Section 7)."

Delete that portion of Section 7 which reads: "Requirements for yield strength are included for such applications as pressure vessels but for most

STRESS VALUES TO BE ADDED TO TABLE UNF-23

Specification Number	Alloy	Temper	Specified Tensile, psi	Minimum Yield Strength	Notes	For Metal Temperatures Not Exceeding Degrees F 100	150	200	250	300
SB-178	GR40A	Annealed	30000	11000	—	7350	7350	7350	7000	6400
		H112								
		H32	36000	26000	—	9000	8950	8850	8250	7400
		H34	39000	29000	—	9750	9700	9500	8800	7900

applications involving the use of alloys 990A, GM51A, GR40A and M1A, yield strength is not important. For these alloys, yield strength need not be determined unless specifically indicated in the contract or purchase order."

Delete footnote *g* of Table II which reads: "Yield strength shall be determined only when specified in the contract or purchase order."

SB-235-57T approved only for alloys 996A-O and H112, GS10A-T42, T5 and T6, GS11A-T4 and T6, M1A-0 and H112 and Clad M1A-0 and H112, and GR40A-0.

Delete Section 2(4) which reads: "Whether yield strength tests are required (Section 7)."

Delete that portion of Section 7 which reads: "Requirements for yield strength are included for such applications as pressure vessels, but for most applications involving the use of alloys 996A, GR20A, GR40A, M1A and Clad M1A, yield strength is not important. For these alloys yield strength need not be determined unless specifically indicated in the contract or purchase order."

Delete footnote *b* of Table II which reads: "Yield strength to be determined only when specified in the contract or purchase order."

SB-241-57T approved only for alloys GS10A, GS11A, and M1A.

Delete Section 2(4) which reads: "Whether yield strength tests are required (Section 7)."

Delete that portion of Section 7 which reads: "Requirements for yield strength are included for such applications as pressure vessels, but for most applications involving the use of alloy M1A, yield strength is not important. For this alloy, yield strength need not be determined, unless specifically indicated in the contract or purchase order."

Delete footnote *d* of Table II which reads: "Yield strength to be determined when specified in the contract or purchase order."

SB-304-56T, except filler metals RN-43, ERN-64, ERN-69, ERN6N and ERN-7W should be deleted and title changed.

SB-308-57T, approved only for alloys GS11A-T6 and GM51A-0, H112 and H311.

The following specifications are deleted:

SB-178 Aluminum-Alloy Sheet and Plate for Pressure Vessel Applications (replaced by SB-209)

SB-273 Aluminum-Alloy Bars Rods and Shapes for Pressure Vessel Applications (replaced by SB-211, SB-221, and SB-308)

SB-274 Aluminum-Alloy Pipe and Tube for Pressure Vessel Applications (replaced by SB-210, SB-235, and SB-241)

WELDING RODS, ELECTRODES AND FILLER METALS

SB-225-57

SB-259-57

SB-260-56T, except delete in Table A Magnesium Brazing Alloy B Mg and Heat Resistant brazing alloy B Ag Mn

SB-285-57

SB-304-56T, except filler metals RN-43, ERN-64, ERN-69, ERN6N and ERN-7W and the title changed.

Unfired Pressure Vessels, 1956

PAR. UG-34(1) Revise reference to ASA B16.5-1953 to read "ASA B16.5-1957."

PAR. UG-44 Revise reference to ASA B16.5-1953 to read "ASA B16.5-1957."

PAR. UCS-8(b) Revise reference to ASA B16.5-1953 to read: "ASA B16.5-1957."

PAR. UCS-25 Revise to read:

Vessels that are to be used in compressed-air service, steam service or water service shall be provided with a corrosion allowance on the metal surface in contact with such substance of not less than the smaller of one-sixth of the calculated plate thickness or $^1/_{16}$ in. This requirement does not apply to unfired steam boilers or to vessels built in accordance with Par. UW-52(b).

FIG. UCS-28.2 Revise the title to add "(Specified Yield Strength 30,000 to 38,000 psi), and Type 405 and Type 410 Stainless Steel".

FIG. UNF-28.14 This chart has been revised. Copies can be obtained from the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.

TABLE UNF-23 Revise to add stress values for Specification SB-178.

FIG. UNF-28.13 Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Aluminum Alloy GR40A or GR40A-H112. Include in Section VIII.

PAR. UHA-28(a) First paragraph, revise to read "rules in Par. UG-28, using Fig. UHA-28.1, Fig. UHA-28.2 or Fig. UCS-28.2."

PAR. UHA-31 First sentence, revise to read "Par. UG-33, using Fig. UHA-28.1, Fig. UHA-28.2 or Fig. UCS-28.2."

FIG. UHA-28.2 Revise that portion of the title in parentheses to read: "Austenitic steels (18 Cr-8 Ni + Mo, Type 316; 18 Cr-8 Ni + Ti, Type 321; 18 Cr-8 Ni + Cb, Type 347, 25 Cr-12 Ni, Type 309 (through 1100 F only): 25 Cr-20 Ni, Type 310)."

PAR. UCL-3 Revise to read:

UCL-3 Conditions of Service Specific chemical compositions, heat-treatment procedures, fabrication requirements, and supplementary tests may be required to assure that the vessel will be suitable for the intended service. This is particularly true for vessels subject to severe corrosive conditions, and also those operating in a cyclic temperature service. These rules do not indicate the selection of an alloy suitable for the intended service or the amount of the corrosion allowance to be provided.

It is recommended that users assure themselves by appropriate tests, or otherwise, that the alloy material selected and its heat-treatment during fabrication will be suitable for the intended service. Where service data are not available, it is recommended that service inspection be made at frequent intervals until the nature and rate of corrosion and extent of metal distortion or other forms of deterioration in service can be definitely established. The data thus secured should determine the subsequent intervals between service inspection and the probable safe operating life of the vessel.

NOTE: Attention is called to the difficulties that have been experienced in welding mate-

rials differing greatly in chemical composition. Mixtures of uncertain chemical composition and physical properties are produced at the line of fusion. Some of these mixtures are brittle and may give rise to cracks during solidification or afterwards. To avoid weld-embrittlement, special care is required in the selection of lining material and welding electrodes, and in the application of controls over the welding process and other fabrication procedures.

PAR. UCL-23(b) Revise to read:

(b) *Integrally Clad Plate Without Credit for Full Cladding Thickness* Except as permitted in (c), design calculations shall be based on the total thickness of the clad plate less the specified nominal minimum thickness of cladding. A reasonable excess thickness either of the actual cladding or of the same thickness of corrosion-resistant weld metal may be included in the design calculations as an equal thickness of base-plate. The maximum allowable stress value shall be that given for the base-plate material in Table UCS-23.

PAR. UCL-23(c) Revise to read:

(c) *Integrally Clad Plate With Credit for Cladding Thickness* When clad plate conforms to one of the specifications listed in Par. UCL-11(a), and the joints are completed by depositing corrosion-resisting weld metal over the weld in the base plate to restore the cladding, the design calculations may be based on a thickness equal to the nominal thickness of the base plate plus S_c/S_b times the nominal thickness of the cladding after any allowance provided for corrosion has been deducted.

Where S_c = maximum allowable stress value for the cladding at the design temperature, psi

S_b = maximum allowable stress value for the base plate at the design temperature, psi

Where S_c is greater than S_b, the multiplier S_c/S_b shall be taken equal to unity. The maximum allowable stress value shall be that given for the base-plate material in Table UCS-23. Vessels in which the cladding is included in the computation of wall thickness shall not be constructed under the provisions of Par. UW-52(b).

PAR. UCL-31 Revise to read:

UCL-31 Joints in Cladding and Applied Linings The types of joints and welding procedure used shall be such as to minimize the formation of brittle weld composition by the mixture of metals of corrosion resistant alloy and the base material.

NOTE: Because of the different thermal coefficients of expansion of dissimilar metals, caution should be exercised in design and construction under the provisions of these paragraphs in order to avoid difficulties in service under extreme temperature conditions, or with unusual restraint of parts such as may occur at points of stress concentration.

PAR. UCL-51 Revise to read:

UCL-51 Tightness of Applied Lining A test for tightness of the applied lining that will be appropriate for the intended service is recommended, but the details of the test shall be a matter for agreement between the user and the manufacturer. The test should be such as to assure freedom from damage to the load-carrying base plate. When rapid corrosion of the base plate is to be expected from contact with the contents of the vessel, particular care should be taken in devising and executing the tightness test.

Following the hydrostatic-pressure test, the interior of the vessel shall be inspected to determine if there is any seepage of the test fluid through the lining. Seepage of the test fluid behind the applied lining may cause serious damage to the liner when the vessel is put in service. When seepage occurs, Par. UA-173 shall be considered and the lining shall be repaired by welding. Repetition of the radiography, the heat-treatment, or the hydrostatic test of the vessel after lining repairs is not required except when there is reason to suspect that the repair welds may have defects that penetrate into the base plate, in which case the inspector shall decide which one or more shall be repeated.

PAR. UCL-55 Revise to read:

UCL-55 General The provisions for stamping and reports in Pars. UG-115 through UG-120 shall apply to vessels that are constructed of integrally clad plates and those having applied corrosion-resistant linings, with the following supplements to the data reports.

(a) Include specification and type of lining material.

(b) Include applicable paragraph in UCL-23 under which the shell and heads were designed.

PAR. UA-6(b) 2(b) Revise reference to ASA B16.5-1953 to read "ASA B16.5-1957."

PAR. UA-173 Add a new Par. UA-173 to read:

UA-173 When the test fluid seeps behind the applied liner, there is danger that the fluid will remain in place until the vessel is put in service. In cases where the operating temperature of the vessel is above the boiling point of the test fluid, the vessel should be heated slowly for a sufficient time to drive out all test fluid from behind the applied liner without damage to the liner. This heating operation may be performed at the vessel manufacturing plant or at the plant where the vessel is being installed. After the test fluid is driven out, the lining should be repaired by welding.

Announcement

Type 321 and Type 347 tubular products processed by cold working and subsequent annealing at temperatures below 2000 F do not warrant usage at the stress values in Tables P-7 and UHA-23 for temperatures over 1000 F. Further study by the Subcommittee on Stress Allowance for Ferrous Materials is now under way so that appropriate revision of the tabulated allowable stresses may be made for these materials in the condition described. Code Case No. 1252 defines the requirements of a new grade, TP-321H of Specification SA-213, for which the allowable stress values listed in Tables P-7 and UHA-23 for SA-213, are applicable.

Welding Qualifications, 1956

TABLE QN-11.2 Revise to read:

TABLE QN-11.2

GROUPING OF ELECTRODES AND WELDING RODS FOR PROCEDURE AND PERFORMANCE QUALIFICATION

F-No.	Classification No.*
Aluminum and Aluminum-Base Alloys	
F-21	R-1060, E-1060 (99.6 min Al) R-1100, E-1100 (99.0 min Al) R-5050, E-5050 (1.2 Mg)
F-22	R-3004, E-3004 (1.2 Mn-1.0 Mg) R-5052, E-5052 (2.5 Mg-0.25 Cr) R-5154, E-5154 (3.5 Mg-0.25 Cr) E-5254, E-5254 (3.5 Mg-0.25 Cr) R-5356, E-5356 (5.0 Mg-0.1 Mn)
F-23	R-4043, E-4043 (5 Si)
F-24	R-SC51A (5 Si-1.3 Cu) R-SG70A (7 Si-0.3 Mg)

Also delete classification number RCuAl-A1 (aluminum bronze) from F-36 in Table QN-11.2 since this has been deleted from SB-259-57T.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

That Ivory Tower

Calling all scientists who live and work in ivory towers: Come down. We know you're up there. Come down and talk to us.

By Leonard Arnow[1]

THEY were a panel of four top newsmen and nine scientists, and they were discussing science and the future. Their audience: Leaders of business, publishing, and education. TV news commentator John Daly, one of the panelists, declared that an uninformed public was the real cause of our missile and satellite lag. He said that scientists must get out of their isolated world, their ivory towers, and learn to talk to the people as do men in such fields as government, law, business, and entertainment.

While he made this comment, missileman and fellow panelist Wernher von Braun nodded his head in firm agreement.

Why is an informed public so important to scientists? Long ago, Abraham Lincoln explained it this way: "Public sentiment is everything. With it nothing can fail. Without it nothing can succeed."

Plain English Would Help

How can scientists reach the public and gain its support? Through the media of mass communication—newspapers, magazines, radio, television, and motion pictures. But scientists have been reluctant to speak to the press unless absolutely necessary. The reason, editors say, is a deep-seated fear of being misquoted or misinterpreted. This in turn may be the result of the "gobbledegook" scientists give reporters. One newsman declared: "Let them use layman's language and spell out the meaning and significance of scientific developments.... This must be done, or we've failed in our responsibility to the public."

The American Institute of Physics conducted an informal canvass which showed that people didn't know what physics was and why it was the basis for science education and engineering. Surprisingly, the canvass also revealed that many engineers didn't appreciate the importance of physics in their work. The reason? Physicists haven't taken the time—or possessed the ability—to tell their story to the public.

Meet the Press Halfway

Even though recent events have increased science news coverage, scientists must take the initiative in reaching the public through the press. Since publications and broadcasting networks cover many fields and a geographical area frequently encompassing the globe, they can't keep on top of every possible news source. Time and personnel are limited. A news service editor summed it up: "If Hollywood gets more press coverage than science, it's because it takes the trouble to work with us. The science and industrial associations could do an important job here, but they don't. They're evasive in supplying information to the press."

In dealing with the press, scientists could help their cause by following a few basic ground rules. First, avoid using words, phrases, and ideas that mean one thing to their colleagues and another or nothing at all to laymen. Keep this in mind when describing abstract ideas. While a scientist qualifies a statement if there's the remotest doubt, he shouldn't overdo it when talking to the public. On the other hand, where qualifications are important they shouldn't be assumed or omitted: The public may not have the background to sense them.

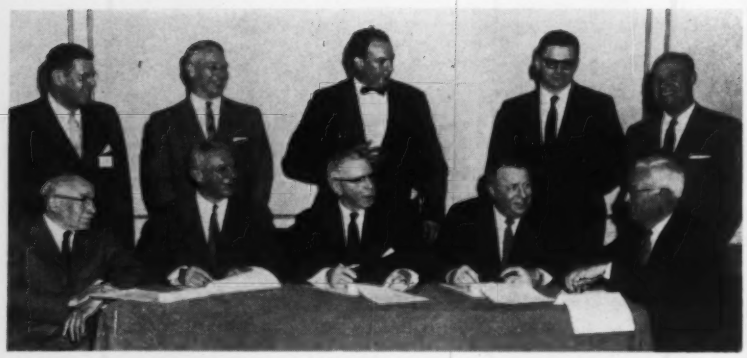
Another press ground rule is significance. Scientists owe it to themselves and the public to relate their work through the press in terms of man's common interests—survival, comfort, hope in the future, spiritual aspirations, entertainment.

A scientist or engineer who gives technical information to a publication should ask to review the story for accuracy. Check it for accuracy of fact and implication, but not for writing style or editorial viewpoint.

Wanted: An Informed Public

An informed public is vital to providing science with the understanding and support it needs. Educating the layman about science and its relation to him won't be easy. It will take a long-term planned effort. It's up to our scientists individually—and collectively through their associations—to marshal enough energy, brain power, and resources to attain this goal.

[1] Public relations counsel, New York, N. Y. This article is a condensation of material submitted by Mr. Arnow.



Induction of the 50-year old American Institute of Chemical Engineers as a Founder Society by United Engineering Trustees, Inc., marked the first time in 42 years that a national engineering society has been admitted to membership. Attending ceremonies connected with the signing of Founders' Agreements are, *left to right,* seated at the table: David W. R. Morgan, past-president, ASME, representing James N. Landis, President, ASME; Augustus B. Kinzel, president, AIME; Walter J. Barrett, president, AIEE and also president, UET; George E. Holbrook, president, AIChE; and Louis R. Howson, president, ASCE. *Standing*, Secretaries: O. B. Schier, II, ASME; Ernest O. Kirkendall, AIME; Steven W. Marras, UET; F. J. Van Antwerpen, AIChE; and William H. Wisely, ASCE.

AEC Submits 900 Papers

LEWIS L. STRAUSS, Chairman of the Atomic Energy Commission, announced that approximately 900 abstracts of scientific and technical papers have been forwarded to the United Nations and proposed for presentation by the United States at the United Nations' Second International Conference on the Peaceful Uses of Atomic Energy to be held in Geneva, Switzerland, on Sept. 1-13, 1958.

The 900 abstracts recommended to the United Nations were selected by reviewing committees from 1478 which were submitted by U. S. scientists to the Commission's Office of International Conference. A number of the proposed papers were recommended for oral presentation at the Conference and all were proposed for inclusion in the official printed records of the Conference proceedings.

Moving Toward a United Engineering

PRESENT LOCATION . . . of Engineering Societies Building is on congested 39th Street in New York. The building, long inadequate, stands amidst the hustle and bustle of the greatest metropolis on earth. For 50 years, with its additions, it has served as nerve center of the engineering profession. Now, as the technology has expanded and the societies have grown, so have their services and activities. This overloaded building is now under severe strain. The answer: A new United Engineering Center.

to United Nations for Presentation at Geneva Conference, September 1–13, 1958

The 1478 abstracts submitted compare with approximately 1000 received for the 1955 Conference. Contributing authors include representatives of industry, educational institutions, hospitals, and government and private research laboratories. Those whose abstracts were forwarded to the United Nations were requested to submit complete papers to the AEC Office of International Conference by April 1.

As at the first U. N. Conference on Peaceful Uses of Atomic Energy, held in Geneva in August, 1955, a technical exhibits program and a technical film program will supplement the presentation of scientific papers.

The industrial design firm of Walter Dorwin Teague Associates, New York City, has been chosen by the Commission to plan, design, and co-ordinate the U. S. Technical Exhibit. The firm designed the United States display at the Vienna, Austria, and the Zagreb, Yugoslavia, Trade Fairs for the U. S. Department of Commerce.

The President of the 1958 Conference will be Prof. W. Perrin of the Commissariat a l'Energie Atomique de France and the Secretary-General will be Dr. S. Eklund of Sweden.

The U. S. Atomic Energy Commission, as in 1955, is in charge of planning, preparing, and presenting the United States technical program at Geneva.

Edward S. Gardner is executive director of the AEC Office for International Conference, which was established to carry out plans for U. S. participation. Dr. L. D. Percival King of the Los Alamos, N. Mex., Scientific Laboratory, is technical director.

The scientific program will be presented in the Palais des Nations in Geneva. The technical exhibit will be presented in an exhibit hall to be built by the United Nations.

Following the 1955 pattern, there also will be a commercial atomic energy exhibit in downtown Geneva. This showing, called the International Exhibition on the Peaceful Uses of Atomic Energy, will be held at the Palais des Exposition. The United States part of the presentation will be co-ordinated by the Atomic Industrial Forum and will feature displays by industry and government.

The United States delegation to the Second Conference is expected to number about 325, the same as three years ago. Members will be chosen on the basis of their contributions to the U. S. program at the Conference. Those coming from industry will participate as individuals not as representatives of their employers.

Center

FUTURE SITE . . . of the United Engineering Center places the headquarters of the Founder Societies, plus 15 additional engineering organizations on United Nations Plaza opposite the UN Building. Overlooking the UN's broad parklike expanse and the East River, the proposed Center will stand as a source of pride to those who helped build it. In addition to the UN, it will be located near the newly completed IBM World Trade Building and Carnegie Foundation. Wide avenues, spacious tree-lined streets, excellent parking facilities are dividends of the new location. The Center, when completed, will serve as the focal point of the engineering profession. With its added facilities the societies and organizations inhabiting the new headquarters will be better able to provide efficient, effective, and economical service. Enlarged Library and publication facilities, adequate committee conference space, modern administrative offices, centralized service areas, and provision for expansion are all part of the new United Engineering Center.

Third U. S. National Congress of Applied Mechanics at Brown University, Providence, R. I.

SPONSORED by the U. S. National Committee on Theoretical and Applied Mechanics, a joint committee of seven national professional Societies of which ASME is one; together with 11 universities; three government agencies; and 16 industrial laboratories, the third U. S. National Congress of Applied Mechanics will be held at Brown University, Providence, R. I., June 11–14.

During the four-day congress the technical program will be presented in 32 sessions. The papers to be delivered deal with dynamics, vibrations, elastic waves, elasticity, elastic structures, plasticity, visco-elastic flow, fracture, fluid flow, aerodynamics, and heat transfer.

In addition, general lectures will be delivered by N. J. Hoff, Mem. ASME, of Stanford University, on creep; H. L. Dryden, Fellow ASME, of NACA, on some aspects of boundary-layer flow in subsonic and supersonic air streams; and Prof. E. Reissner, of M.I.T., on rotationally symmetric problems in shell theory.

There will be a publishers' exhibit. Conferees will have the opportunity to see the current publications in the field of applied mechanics by Academic Press, Inc.; John Wiley & Sons; Prentice-Hall, Inc.; and *Applied Mechanics Reviews*.

Of interest will be a visit to the Physical Sciences (Corthell) Library of Brown University which is noted for its excellent collection of literature on Applied Mechanics. Perhaps, some will have time to see the John Carter Brown Library collection of early Americana.

MEETINGS OF OTHER SOCIETIES

June 16–18

Iowa Institute of Hydraulic Research, hydraulics conference, State University of Iowa, Iowa City, Iowa.

June 16–20

American Society for Engineering Education, annual meeting, University of California, Berkeley, Calif.

June 22–25

American Society of Agricultural Engineers, annual meeting, University of California, Santa Barbara, Calif.

June 22–27

American Institute of Chemical Engineers, golden jubilee celebration, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 22–27

American Society for Testing Materials, annual meeting and exhibit, Statler Hotel, Boston, Mass.

June 22–27

Forest Products Research Society, national meeting, Loraine Hotel, Madison, Wis.

June 23–25

American Society of Heating and Air-Conditioning Engineers, semi-annual meeting, Nicollet Hotel, Minneapolis, Minn.

June 23–25

American Society of Refrigerating Engineers, annual meeting, Leamington and Curtiss Hotels, Minneapolis, Minn.

June 30–July 5

International Institute of Welding, annual assembly, Vienna, Austria.

July 8–11

Institute of Aeronautical Sciences, national summer meeting, Ambassador Hotel, Los Angeles, Calif.

(*ASME Coming Events, see page 135*)

Teachers Needed to Train Engineers

The crisis in technological education revealed in two-year study by ASEE

THE shortage of well-qualified engineering teachers will grow even more serious unless the nation is willing to pay the price of attracting top talent into the field, a report made public April 27, declared.

The report was based on a two-year study of what its authors call "the crisis in technological education," sponsored by a special Committee on Development of Engineering Faculties of the American Society for Engineering Education.

The study was made by the Bureau of Business and Economic Research at Northeastern University, Boston, Mass., under the executive direction of Dr. W. H. Miernyk, now visiting professor of economics at M.I.T., and Dr. M. A. Horowitz, associate professor of economics at Northeastern. Financial support was provided by the National Science Foundation with added grants from the Burroughs Foundation, the Leeds and Northrup Foundation, the Philco Corporation, and the International Resistor Corporation.

The study found that mounting enrollments and other factors would create a need for 7000 more engineering teachers by 1966–1967. Last year, the nation's engineering colleges employed about 9000 engineering teachers.

Their salaries should average $12,500 in 1967 dollars, 105 per cent more than today's average.

The total salary bill should be $200 million, an increase of 233 per cent.

The quality of America's technological education in the next ten years depends critically upon meeting these needs.

An additional 732 engineering teachers, the report declared, would have been required last year to bring all engineering faculties to full strength, and another 500 would have been needed to replace part-time, temporary, or unsatisfactory personnel. "The shortage, as thus defined," said the report, "is already significant. Subtle, creeping compromise with quality faculty standards is thus already reported by many deans."

The findings, said Dr. H. L. Hazen, dean, Graduate School, M.I.T., and chairman of ASEE's committee, present an urgent challenge: Can American education pay the price necessary to attract top talent into engineering teaching careers?

EDUCATION

Engineering-Education Study

CASE Institute of Technology, Cleveland, Ohio, has been granted $106,600 from the Carnegie Corporation of New York for a one-year program of study and action aimed at producing major improvements in engineering education.

Learning Russian

• CARNEGIE Institute of Technology will offer a summer course in Scientific Russian in answer to increasing needs of graduate students and research workers. It will be specially designed for graduate students in engineering and science, but may be taken by others as well.

The 18-unit course, equivalent to a full year of work, will meet for two hours each morning Monday through Friday, from June 16–August 9. No

previous language training is required.

• A course in basic Russian has been offered twice weekly since February 4, over WRGB-TV, Schenectady, N. Y., from 6:30 to 7 a.m. General Electric, owner of the station, sponsors the program with the Mohawk-Hudson Council on Educational Television and the northeastern branch of the American Chemical Society.

Summer Courses

The Massachusetts Institute of Technology is offering a number of special summer courses. Tuition for the courses, a sampling of which follow, is $250:

Cavitation Mechanics in Engineering Practice, July 8–18, Dr. J. W. Daily, Department of Civil and Sanitary Engineering.

Fluid Power Control, July 8–18, Dr. J. L. Shearer, Department of Mechanical Engineering.

Modern Developments in Heat Transfer, July 8–18, Dr. W. M. Rohsenow, Department of Mechanical Engineering.

Principles of Radioisotope Utilization, July 14–25, Dr. G. L. Brownell, Department of Nuclear Engineering.

For details of each program, direct inquiries to the faculty member in charge of it.

• California Institute of Technology's Management Development Center, Pasadena, Calif., is presenting six one-week summer courses. Psychology for Management, Essentials of a Retirement Program, and Administering an Executive Development Program will be offered the week of September 7–12. Supervision of Engineers, Selecting and Appraising Employees, and Management Techniques and Controls are the conferences offered from September 14–19. Enrollment in each of the conferences is limited to 22, fee for each is $175.

• University of California, University Extension, Los Angeles, Calif., is offering an intensive lecture and laboratory program in Strain Gage Techniques. The courses, presented by the department of engineering and the Society for Experimental Stress Analysis, will be divided into lectures, August 18–22, and laboratory, August 25–29. Tuition for each course is $175.

The same institution in co-operation with the Los Angeles section of the American Society for Quality Control is giving a course in Statistical Methods in Industry, August 11–22. Information may be obtained from E. P. Coleman, College of Engineering, University of California, Los Angeles 24, Calif.

• The University of Michigan, College of Engineering, has announced an intensive course in Dynamics of Flight. The course will be given from September 8–13. Closing date for registration is July 14. For further information write: Professor R. M. Howe, Room 1523, East Engineering Building, University of Michigan, Ann Arbor, Mich.

New Curriculums

The University of Rochester has announced the establishment of a College of Engineering as one of three new professional units under a major reorganization of its academic and administrative subjects, effective Sept. 1, 1958.

The new college will combine the long-established Departments of Chemical and Mechanical Engineering, and the new Department of Electrical Engineering. It will have its own dean and administrative staff and will have the full freedom of action necessary to its best professional development.

• Graduate study leading to a master of science degree in nuclear science was announced by Clemson College, Clemson, S. C.

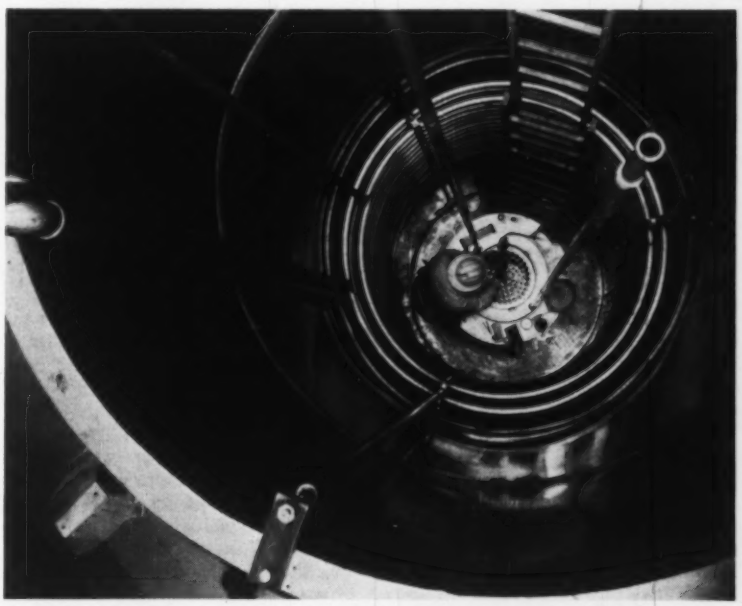
The new, forward-looking program, endorsed by the educational council, became effective February 1. It is the first graduate work in nuclear studies being offered in South Carolina.

Dr. Jack Williams, acting dean of the Clemson Graduate School, said course work would be divided in chemistry, mathematics, and physics and that thesis research would be done in the Du Pont Laboratories of the Savannah River AEC Operations Plant at Aiken.

Enrollment will be limited. College graduates in chemistry, mathematics, and physics are eligible to apply. Additional candidates may qualify with undergraduate engineering backgrounds.

Campus Development

Fenn College trustees have authorized acceleration of a $4 million construction program originally planned in two steps. Conversion of the former Ohio Motors Building will proceed immediately. It will be completed by the Fall of 1959, in time to accommodate the coming enrollment bulge. The College's instructional plant will be doubled. The new Library will more than double the seating capacity of the old, while tripling its collection of approximately 37,000 volumes. The new construction will provide fully equipped laboratories in chemical, civil, electrical, mechanical, and metallurgical engineering; and in anatomy, bacteriology, biology, chemistry, nursing science, physics, and physiology.



Scientist positions a control-rod guide tube in the reactor-core grid plate of General Atomic Division of General Dynamics Corporation's prototype, 10-kw TRIGA reactor. The University of Arizona at Tucson will be the first educational institution in the world to have the newly developed, multipurpose, inherently safe TRIGA reactor, it was announced jointly by the University and General Atomic. Installation of the training, research, and isotope production reactor will take place this fall on the University campus.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME to Split Transactions Into Three Quarterlies

Journal of Applied Mechanics continues as fourth Transactions quarterly

BEGINNING in January, 1959, the *Transactions of the ASME* will be published as a series of four quarterlies (MECHANICAL ENGINEERING, May, 1958, page 55.) The new plan, as set up by the Publications Committee, was formally approved by the Board on Technology and the Executive Committee of Council (p. 151 of this issue). In addition, the chairmen of all ASME Professional Divisions, Research, and other Committees, were apprised of the new scheme.

Thus with the existing *Journal of Applied Mechanics*, the *Transactions* will include the *Journal of Basic Engineering*, *Journal of Power Technology*, and *Journal of Industry Technology*. (Titles are tentative.)

Tables 1 to 3 list the subjects which will be included in each of the new journals. Papers recommended for *Transactions* will henceforth be channelled into the proper journal in accordance with this subject breakdown.

Table 4 lists the subject matter covered in the *Journal of Applied Mechanics*.

In going to this new publication plan, it is proposed to add some new features to each of the new quarterlies. One such feature would be a section or department entitled "Technical Briefs." This would be similar to the "Brief Notes" department in the *Journal of Applied Mechanics* and would consist of worthy contributions of 750 words or less including one or two illustrations. Such contributions, however, should be reviewed and approved by the specific division's reviewing committee prior to publication.

In addition, the covers for the four quarterlies are being redesigned (see illustrations) and the format of the editorial content is being revamped.

At the same time, the Publications Committee, the Board on Technology, and the Executive Committee, because of rising printing costs (60 per cent since 1945) and increased volume of material to be published (90 per cent since 1945) voted to increase subscription rates for *Transactions*.

The price schedule adopted for the new quarterlies and which begins in January, 1959, is as follows:

No. of Journals	Member Price	Nonmember Price
1	$ 5.00	$10.00
2	9.00	18.00
3	12.50	25.00
4	15.00	30.00

All ASME members will be afforded an opportunity to subscribe to the new journals on the Annual Dues Statement which will be mailed to the membership in August.

With this new plan, the officers and staff of ASME hope to render a better service to the membership by publishing the *Transactions* in more usable packages.

Admiral Rickover Scores School Equality as Barrier to U. S. Mental Growth

Principal Speaker at BPI Installation of New President

EQUAL treatment of all pupils in the name of democracy has ruined the nation's elementary and high-school education, asserted Rear Admiral Hyman G. Rickover, 1955 ASME George Westinghouse Medalist.

The admiral, a frequent critic of American public education, spoke at the inauguration of Dr. Ernst Weber as president of the Polytechnic Institute of Brooklyn. The ceremonies were held outdoors before the new building of the institute at 333 Jay Street in Brooklyn.

"We waste the best years of our children in the name of democracy and of the sacred comprehensive school," Admiral Rickover said. He said such a school "must cater equally to children of such diverse mental capacities that, among one age group, the mental age between the least and the most-gifted may differ as much as six years."

Proper School for Each Child

"The careful manner with which European school authorities seek to find the proper type of schooling for each child's individual gifts is often criticized here as cruel and undemocratic," he said. "Weeding out by means of examinations, in particular, arouses pity and horror. Most Americans seem to regard education as a sort of commodity or service which anybody ought to be permitted to 'get,' simply by paying tuition or by having the cost of education met through taxes."

"I fear," he said, "we shall not have real improvement in our educational system until it is widely understood that education is and always has been something which money alone cannot purchase. The only acceptable coin which buys an education is hard intellectual effort. How much education can be bought with mental effort depends on the quality of the teacher and of the pupil. Strong motivation can often offset a modest I.Q. All that a democratic government can do to insure educational equality for all its children is to throw open the school to everyone who will make the effort to learn. This, most of our European friends have long been doing. Insistence on intellectual effort is where we have fallen down.

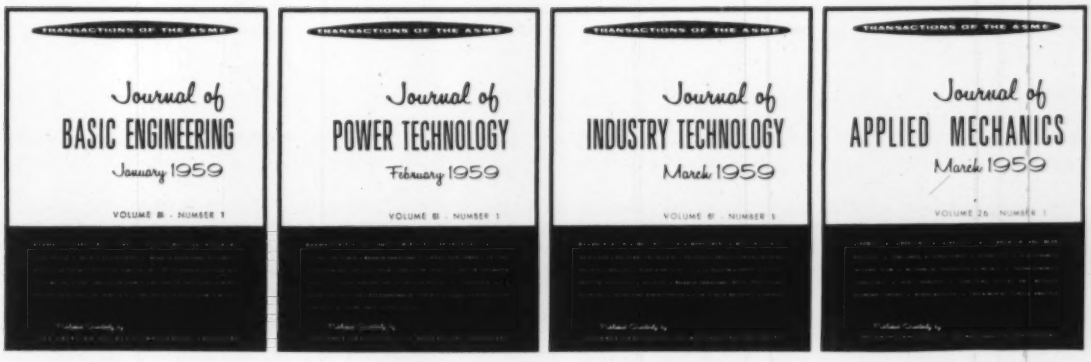


Table 1
Journal of Basic Engineering

DIVISIONS

Heat Transfer
Hydraulic
Instruments and Regulators
Lubrication
Metals Engineering

RESEARCH COMMITTEES

Automatic Regulation Theory
Effect of Temperature on the Properties of Metals
Fluid Meters
Heat Conduction Charts
Lubrication
Mechanical Pressure Elements
Plastic Flow of Metals
Prevention of Fracture in Metals

Table 2
Journal of Power Technology

DIVISIONS

Power
Gas Turbine Power
Nuclear Engineering
Fuels
Oil and Gas Power

RESEARCH COMMITTEES

Boiler Feedwater Studies
Condenser Tubes
Corrosion and Deposits From Combustion Gases
Furnace Performance Factors
High-Temperature Steam Generation
Properties of Steam

OTHER COMMITTEES

Power Test Codes
Air Pollution Controls
Solar Energy Application

Table 3
Journal of Industry Technology

DIVISIONS

Aviation
Machine Design
Management
Wood Industries
Maintenance and Plant Engineering
Railroad
Production Engineering
Materials Handling
Rubber and Plastics
Petroleum
Safety
Textile
Process Industries

RESEARCH COMMITTEES

Elevators
Engineering Administration
Flow of Bulk Materials
Mechanical Springs
Metal Processing

Table 4
Journal of Applied Mechanics

Elasticity
Plasticity
Dynamics
Vibration
Impact
Flow and Fracture
Structures
Stress Analysis
Mechanical Properties of Materials
Hydraulics
Aerodynamics
Internal Flow
Turbulence
Boundary Layers
Aeroelasticity
Thermodynamics
Heat Transfer
Lubrication and Wear
Computing Devices and Methods

"Children may not only be barred from mental growth where high tuition withholds education from poor children. Just as much harm may be done when pupils are forced into an intellectual straitjacket for the sake of democratic equalitarianism.

"A school system that insists on the same instruction for the talented, average, and below-average child may prevent as many children from growing intellectually as would a system that excludes because of social, political, or economic status of parents. Neither system is democratic."

Admiral Rickover also condemned what he called the domination of American universities and schools by administrators rather than scholars. He called for a unified educational system with uniform national standards to supersede the authority of 50,000 local school boards.

Back to the Liberal Arts

He scorned "trivial" courses demanding a return to basic arts and sciences in secondary schools and colleges. "The school's concern is with the intellect alone," he said. "Young people in this modern world need minds that are well stocked with the kind of knowledge that makes life intelligible. No substitute for a liberal arts education has yet been invented that serves this purpose so well. English, foreign languages, mathematics, sciences, history, geography—these are the subjects which must be mastered. They are the intellectual tools that enable us to order our lives intelligently—to understand the complexities of today's tense and uncertain world."

Dr. E. Weber Installed as President

Dr. Ernst Weber who has actually been president of the institute since December, 1957, declared in his inaugural address that national programs of research in science today were "well intentioned but pernicious." The system requires, in advance, a detailed outline of what the scientist intends to discover, he said.

"I submit that this is stimulating mediocre research where you dare not think originally," Dr. Weber said. "True scientific research cannot be planned in all details. Grants should be made to qualified people without restrictive covenants and terminal dates for accomplishment."

Honorary Degrees Conferred

Honorary degree of Doctor of Engineering was conferred upon Admiral Rickover and Edward E. Kleinschmidt, inventor of the Teletype. Honorary

(*Continued on page 143*)

R. E. Clarridge, *left,* receives from ASME President Landis a certificate for his service to the Division's Executive Committee. He was Chairman in 1956.

Fourth IRD Conference Advances "Automatic

At the University of Delaware, the Instruments and Regulators Division of The American Society of Mechanical Engineers held its fourth annual conference, April 2–4, 1958. The meeting, held in co-operation with the ASME's Delaware Section, also enjoyed the participation of American Institute of Chemical Engineers, the Institute of Radio Engineers, the Instrument Society of America, and the American Institute of Electrical Engineers.

The men of the IRD are blessed—or burdened—with a special knowledge that could make them smug, if they had time to be smug. They know they are one of the branches of science and engineering that will carry the ball in the years to come. At the IRD banquet, J. N. Landis, President of the ASME, quoted a report in which a knowledgeable engineer made an estimate of life in 1978. Quite seriously it was predicted that the value of the automatic controls would exceed the cost of the plant itself in that enlightened year. Man is going to design electronic controls to do, with precision, what he himself does so imperfectly.

Visitors From Russia

Among the 200 engineers who met at the Newark, Del., campus were three from the Soviet Union, invited to this country by the IRD to get acquainted with their American counterparts. Two of the Soviet visitors presented technical papers.

The time and the place were happily chosen. The Soviets enjoyed four sunny spring days in an American college town of rich colonial history, in America's first state. It was King George II who, in 1758, took a moment from his merrymaking to authorize the granting of a charter to the town of New Ark in the Penn grant. Washington's troops passed through during the campaign that ended in the Battle of the Brandywine. Today Newark (still pronounced New Ark) is a small, quiet town, graced with the pleasant campus of the University. IRD conferees were quartered in dormitories (the students were away on Easter vacation), and meals were served in the college cafeteria.

Automatic Optimization

Automatic controls can never be perfect. In past years, the Division has met to hear and discuss papers on questions of the controls themselves, on means of achieving near-perfection. That is: If 300 F were the ideal temperature for a certain control point, how close could automatic controls hold to the mark?

But this year the Division turned its attention to the final step: Is 300 F really the ideal temperature for maximum efficiency, for maximum earnings? Or would 305 F be better? In short, how do you optimize the entire process, so that automatic controls produce the maximum profit for the plant? That was the question debated by more than 200 engineers from 25 states, and from Hawaii, Canada, and the USSR—though the USSR probably doesn't use the word "profit."

Technical papers emanated from Princeton, Columbia, M.I.T., U. of Minnesota, U. of California, and Case Institute. Others came from the laboratories of Westinghouse, Daystrom Systems, du Pont, Ramo-Wooldridge, IBM, U. S. Navy, Beckman Systems, General Electric, Aeronutronics Systems, and Brown Instrument (Minneapolis-Honeywell). Bailey Meters, American Cyanamid, and Elliot Brothers (England) were represented in a panel discussion. The two Russian papers represented the Institute of the Academy of Science of the USSR.

(Later, at a press conference in New York, Alexandr B. Tcheluskin, the English-speaking member of the Soviet team, answered questions regarding technical conferences within the USSR. He said it was not customary to hold gatherings like the one at Newark. Instead, Soviet engineers do a great deal of traveling, going from one installation to another, each man seeing how the others do it, a series of individual conferences.

He stated that Soviet institutes [colleges] first set up faculties in automatic controls in 1934, and that today most polytechnic institutes have such faculties. In the Soviet Union, as here, there is the argument as to what is "Self-adaptive, self-adjusting." When do automatic controls become automation?)

The Wednesday evening session (April 2) saw an ISA film on frequency response, a short movie performed and narrated by D. M. Boyd, Mem. ASME, of Universal Oil Products. The film proved to be a remarkably skillful and entertaining presentation of the facts of automatic control. Even the wives of conferees, attending the show out of grim togetherness, found themselves delighted and instructed by Mr. Boyd's film.

Going Places, Seeing Things

Thursday was the day when technical sessions gave way to field trips and social gatherings. At Du Pout, in Wilmington, Del., a limited number of conferees could visit the Mechanical Development Laboratory. A larger group, which included the Soviet guests, enjoyed a conducted tour of Tidewater's huge Delaware City Refinery. In addition to an advanced control center, they saw the largest crude distillation unit ever built.

For the ladies, there was a tour of Winterthur, a museum of early Americana collected by Emory du Pont. The day before, they had been offered an enlightening trip to the Delaware State "Health Center."

President Landis at the Banquet

Just outside Wilmington there sits the Du Pont Club, built by Du Pont for its employees. There, in surroundings unrivaled by any but the most lavish hotels, the conference held its banquet. President Landis and his family were there to meet the conferees and to do honor to the Soviet visitors.

J. H. Hrones calls for a hard reappraisal of educational goals. The vice-president for Academic Affairs at Case blasted current emphasis on conformity.

The Division's Soviet guests greeted by President Landis. *Left to right:* Alexandr B. Tcheluskin, Prof. Avenir A. Voronov, Vladimir D. Pavlov, President Landis. Prof. Voronov delivered a greeting to the Society from the Academy of Science of the USSR. He and Mr. Tcheluskin presented papers at the technical sessions.

Optimization"

At the University of Delaware, ASME's Instruments and Regulators Division is host to Soviet engineers. AIChE, IRE, ISA, and AIEE participate.

C. R. Otto of Du Pont, and of the IRD Executive Committee, made the introductions. He welcomed the conferees to Wilmington, and he emphasized that this was a co-operative conference in which the AIChE, the IRE, the ISA, and the AIEE took part with the ASME's Instruments and Regulators Division and Delaware Section.

President Landis introduced the three Soviet guests, presenting them as fellow engineers come to us for "free exchange of knowledge," and urged that there be more interchange between our men of science and those of the USSR.

Prof. Avenir A. Voronov then made a brief address. He spoke in Russian, and afterward his speech was read in English by W. A. Patterson, the interpreter sent by the State Department. Professor Voronov brought to us the greetings of the Academy of Science of the USSR, "from Soviet engineers to the engineers of the United States."

Three members of the ASME received awards from President Landis. Two who received Certificates for their services on the Executive Committee of the Division were R. E. Clarridge of Taylor Instrument, and J. A. Hrones, formerly of M.I.T., now vice-president for Academic Affairs at Case Institute. Mr. Hrones was the main speaker at the banquet.

J. C. Peters of Leeds and Northrup received a Citation for important engineering in the field of Instrumentation and Regulation.

An Educator Speaks Out

As main speaker, Professor Hrones delivered a fighting talk on the weaknesses and needs of our educational system. In so far as the Soviet visitors were able to interpret him, they heard an example of frank American self-criticism. Professor Hrones blasted our present emphasis on conformity, our developing of "Interchangeable men" whose jobs are presumably secure.

"The interchangeable man," he said, "is no man at all. He does not know what freedom is, and it is by no means certain he would want freedom if he knew what it was. . . . The true role of education is to develop intellectual power and add to knowledge."

He made the disquieting statement that our educational system is not ready for optimization because we do not understand the system to be optimized.

"We must have the courage," he said, "to shake loose from their daily tasks the men who can formulate new policy. We've got to find out what our job is."

President Landis closed the meeting with remarks on the great development in control equipment expected during the next 20 years. He quoted from a talk given before Southeastern Electric Exchange, April 1, by Tomlinson Fort, Mem. ASME, and a vice-president of Westinghouse—a report to fire the imagination of the men of the IRD.

An Automatic World

"In 1978," President Landis read, "whole plants will run automatically from marketing information fed into them on cards and tapes. In most cases, the value of the control equipment will far exceed that of the plant itself. . . . Several hundred thousand engineers, technicians, and highly skilled maintenance men will be spending their full time on the care and feeding of thousands of electronic computers. . . . There is a tremendous backlog of important new principles and theories, new products and processes, building up. . ."

AVAILABILITY LIST: INSTRUMENTS AND REGULATORS PAPERS

The papers in this list are available in separate copy form until February 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Department, 29 West 39th Street, New York 18, N.Y. Papers are priced at 25 cents to members; 50 cents to nonmembers.

Paper No.	Title and Author
58—IRD-1	An Adaptive Humidity-Control System, by G. K. Tucker
58—IRD-2	An Optimalizing Computer Controller for the Electric-Utility Industry, by L. K. Kirchmayer
58—IRD-3	Gyro-Integrating Mass Flowmeter, by L. T. Akeley, L. A. Batchelder, and D. S. Cleveland
58—IRD-4	Dynamic Analysis of a Boiler, by K. L. Chien, E. I. Ergin, C. Ling, and Allyn Lee
58—IRD-5	Continuous Measurement of Characteristics of Systems With Random Inputs: A Step Toward Self-Optimizing Control, by T. P. Goodman and R. H. Hillsley
58—IRD-6	Optimal Synthesis of Linear-Sampling-Control Systems Using Generalized Performance Indexes, by R. E. Kalman and R. W. Koepcke
58—IRD-7	Subharmonic Oscillations of Nonlinear Feedback-Control Systems, by Katsuhiko Ogata
58—IRD-8	Time Domain Synthesis of Sampled-Data Control Systems, by E. I. Jury and F. W. Semelka

Russians visit Delaware Refinery. Three technical specialists from the Soviet Union recently visited Tidewater Oil Company's new 130,000-barrels-per-day Delaware Refinery. The three were guests of The American Society of Mechanical Engineers at its fourth annual IRD conference, held at the University of Delaware. Shown inspecting the desulfurizer unit are, *left to right:* A. B. Tcheluskin; A. A. Voronov; V. D. Pavlov; and Frank J. Dawson, senior estimator, Tidewater Oil Company, Delaware Refinery. The Russians, who are instrument specialists, participated in activities of the Instruments and Regulators Division at the three-day ASME conference.

ASME Is Host to Engineers From the Soviet Union

First interchange under the Zaroubin Agreement takes place when Soviet engineers are invited to IRD Conference

On March 31, 1958, three engineers from the USSR arrived in New York as guests of The American Society of Mechanical Engineers.

The Soviet engineers had accepted the invitation of the ASME's Instruments and Regulators Division to attend the fourth annual IRD conference at the University of Delaware, Newark, Del.

This was the first visit of Soviet engineers to this country under the arrangement worked out between our State Department and former Soviet Ambassador Zaroubin.

In operation the Zaroubin Agreement calls for reciprocal exchanges on an evenly matched basis. Originally, a 15-day postconference tour to American industrial centers had been planned for the visitors: But this was a "first," and errors of omission cropped up, delaying completion of arrangements until it was too late.

From the Other Side of the World

Difficulties notwithstanding, three of the USSR's specialists in instrumentation and regulation did pass through the new International Arrival Building at Idlewild on the morning of March 31. They were: Prof. Avenir A. Voronov of the Electromechanical Institute of the Academy of Science at Leningrad; Alexandr B. Tcheluskin, a specialist in electrical energy in steel mills; and Vladimir D. Pavlov, whose work is with oil refineries. Tcheluskin and Pavlov are both of the Institute of Automatics and Telemechanics, Moscow. All three of the Soviets were concerned with automatic control of industrial processes.

The word "Soviets" is used correctly, here. There are many parts of the USSR where the people are not Russian, and do not speak the Russian language. "Soviets" is the inclusive and proper word. This information came from the young man assigned as escort by the State Department, William A. Patterson.

At the Newark conference, the visitors presented two technical papers. Professor Voronov's paper took up "Digital Computers for Programming Machine Tools"; Mr. Tcheluskin spoke on "Automatic Control Systems With Correlating Actions." Both men spoke in English. Professor Voronov, inexperienced in spoken English, had translated his paper and prepared its delivery so that it came over clearly, but he needed the help of the State Department interpreter to handle questions and discussion.

Mr. Tcheluskin, on the other hand, had lived in America for most of three years after World War II, representing the Soviet steel industry in the purchase of machinery. His English was definitely operational despite more than ten years of disuse. The third guest, Mr. Pavlov, made no attempt at English, but he was fluent in German. In this he found common ground with Rufus Oldenburger of Purdue University and T. P. Goodman of Massachusetts Institute of Technology.

The American Scene

Dr. Oldenburger played host to the Soviets on behalf of the Division. During their stay in Newark he saw that they were taken to supper in Wilmington, and to such American institutions as a drive-in restaurant and a supermarket. He took them to a real-estate development which exhibited a model split-level house. The visitors expressed surprise at three things: The great number of automobiles; beer in cans; the small amount of bread at American meals.

At the IRD banquet, Prof. Voronov delivered a speech of greeting, a hands-across-the-sea message from the engineers of his country to those of the United States.

On Friday, April 4, they attended the final technical session at Newark, then traveled to Washington in the automobile of an ASME staff member. In Washington they were largely on their own, since Mr. Tcheluskin knew the city from his earlier stay in America and had friends to look up. To this reporter he spoke of his great pleasure in talking to the people in the Soviet Embassy, some of whom had not been home to Russia in years and who plied him with questions about Moscow.

Sunday Dinner in Suburbia

Perhaps, the happiest event of the entire visit was Sunday dinner, when the visitors were guests of Mr. and Mrs. Patterson at their home near Alexandria, Va. The Soviets saw American life as

we'd like them to remember it—a young couple with four children living in a modern home in the suburbs.

Then . . . back to New York for a press conference and sight-seeing. What did they want to see? Above all, they wanted to get to Macy's to buy gifts for their children. At a meeting with the editors of the technical press, held in the Engineering Societies Building, Mr. Tcheluskin answered questions about Soviet interchange of technical information (they don't have conferences like the one at Newark), automatic control technology in the USSR, and Soviet college (institute) courses. In their institutes the students choose their courses during the first two years, but "in the second year they begin to find their destination."

Do Skoroga Svedanie

At a luncheon in the Engineer's Club, Professor Voronov told a group from industry and the Founder Engineering Societies that he and his friends were grateful for their visit to the United States, that it had been a success. He felt the exchange of information had been extremely useful, with new avenues opened up, and he hoped to welcome members of the ASME to Russia in the near future.

This was most gracious on the part of the Soviet visitors, since they had hoped —right to the end—that their stay could be lengthened to include visits to many industrial centers. But the diplomatic problems could not be solved in the time available. On Tuesday, April 8, the three Soviet engineers said their "do svedanie" (good-bys) and went aboard a plane for their homeward flight, having had eight days in this country.

Lessons Learned the Hard Way

From the difficulties encountered in this first exchange under the Zaroubin Agreement, lessons were learned that should smooth the path for future exchanges. T. A. Marshall, Jr., senior assistant secretary of the ASME, is drafting a report that will advise officials of the Society throughout the country on how to proceed in arranging visits of foreign engineers. In the case of engineers from the USSR, and from Asia and Eastern Europe, plans must be made well in advance, and certain diplomatic clearances obtained. As part of its obligation to promote the exchange of information on technical subjects and to "advance the art and science of mechanical engineering," the Society will co-ordinate exchanges of visits between engineers of the United States and those of foreign countries.

Current Status of Automatic Techniques Discussed at First AIEE, ASME, IRE Conference

Detroit meeting ushers in a successful forum

THE current status of automatic techniques, their application to engineering computations and design studies, their use as process components, and for industrial controls were among the topics of the first annual joint conference on Automatic Techniques at Detroit, Mich., April 14–16, 1958.

Technical Sessions

Twenty papers were presented in the sessions sponsored by the American Institute of Electrical Engineers, The American Society of Mechanical Engineers, and the Institute of Radio Engineers. The ASME papers were a representative cross section of the technical sessions. There were five specific application studies, a discussion of Boolean algebra and its use in the design of sequential control for chemical batch processes, and a theoretical study of the limitations of large computers as related to programming and laboratory organization.

J. W. Hopper of Pratt & Whitney, Assoc. Mem. ASME, presented a survey of the basic gages and gaging considerations for automatic machine control, particularly those used for dimensional measuring. These are largely direct-reading gages, and comparator types of pneumatic, mechanical, and electrical operation. The accuracy limits of this equipment and the errors introduced by the thermal expansion of materials need not be handicaps if they are understood. Major gaging suppliers have embarked on programs to provide practically the whole gamut of sorting and control systems for nearly any application. Accurate measuring devices are basic to these systems.

One of these applications, the use of punch-card control for dynamic batch weighing, was described. A straight decimal format is used on these cards which require only three spaces for each selection. These control the resistors which are locked into the bridge circuitry of the digital batching-control panel. The sensing and regulatory functions make use of such standard components as load cells and level controls for the development of an integrated system in which the programming of time and proportioning serves to control all functions other than the original selection of weights.

Another basic component of automatic techniques, the servo, was the subject of a paper. The versatility of this device and a description of a particular electrohydraulic model with wide potential for industrial application were discussed. Four specific applications—test-stand drive, positioning, synchronizing, and machine-tool contouring—were developed in some detail. Functions, capabilities, versatility, economics, and some special inherent problems were also dealt with.

A survey of the application of automatic devices for electric-power generation was given by A. C. Hartranft and F. H. Light, Mem. ASME, both of Philadelphia Electric Company. The paper provided a review of the principal areas in which automatic control has already been applied. Local automatic-control centers have developed in power plants as larger turbines and boilers have been installed, since manual control cannot cope with the rapid changes in load. The principal control devices now monitor and regulate feedwater, fuel and other combustible elements, and steam temperature as well as the sequential operation of many auxiliaries, and the protection of turbine and generator through relay tripping devices. With centralized control, operation is fully automatic except for the starting and stopping of certain auxiliaries, the filling of the coal bunkers, and the chemical treatment of the feedwater. Even manual logging of data is yielding to the automatic typewriter which periodically records data on typewritten forms. The present trend toward further interconnection of neighboring systems for the realization of the economic advantages of load diversity, reserve capacity, and interchange power may be the deciding factor in favor of automatic control of system load.

A two-part paper covered some typical applications of the computer to system and design studies in the automotive industry, and the use of a digital technique which performs all of the subsequent calculations in the study of large classes of vibration systems once an idealized structure has been developed. To a degree, the computer performs limited problem analyses since it can calculate a number of variables to provide the best solution to the required combination of masses, spring and damper rates, lever ratios, and other factors.

(*Continued on page 147*)

Preparing slides for evening session, ASME Production Engineering Conference, Worcester, April 10, are, *left to right,* R. H. Tolman; C. E. Crede, Vice-President, ASME Region I; W. B. Pirnie, Jr.; and W. R. Elmendorf

ASME Production Engineering Conference Emphasizes New Control Techniques

Mathematicians have important place, with engineers, in production and

"New Techniques for Production and Inventory Control," theme of the Production Engineering Conference, held April 10 at the Bancroft Hotel, Worcester, Mass., was amply illustrated in the technical program.

During the conference, more than 120 engineers heard the subjects discussed marking the beginning of the use of new, scientific tools in the problems of economical inventory control and production processes. From several sources it was evident that the mathematician is finally coming into his own. A number of companies reported that mathematicians are employed now in the laboratories to work on production control through the use of computers.

Through the speed of calculations possible with computers, mathematical and statistical problems which formerly existed in theory can be worked for actual production and inventory problems. The result is that economical inventory sizes, reordering points, and the like can be predicted and controlled with greater accuracy than before. Frequently, a variety of information can be obtained from a given set of data fed into a computer and correlated in an extremely short time. Doing these same calculations manually would be impossible. Moreover, the conference brought to the attention of the production engineers in attendance the idea that computers have a place in industry, even small industries, for solving the everyday problems that engineers have had to cope with for years.

Afternoon session speakers, Robert G. Brown and Nyles V. Reinfeld, check program with Earle C. Miller, chairman of ASME Worcester Section, at conference

New Tools—New Language

New tools have brought new language. The accomplishment of any work task by a power-driven, integrated machine, wholly without the direct application of human energy, skill, or intelligence is how automation is defined at General Electric Company. The word is defined further as a universally applicable systems philosophy comprising industrial research, economic analysis, product design, machine design, machine construction, and machine utilization. Automatology, another term not likely to be found in a dictionary, is described as the process of establishing, developing, and applying the principles of automation. The term was coined by the men in GE's electronics work to stress the fact that an over-all systems approach to automation is much more than just the utilization of machines; it is a technology.

An integrated data-processing system to control production and inventory was described which traced the development of the system from market-sales forecasting to control reports on the finished product. A computer is used to implement the operation and analyze all statistical data. The order-point concept is employed as well as a component-parts-requirement program.

Examples were given of stock records, which show date, sales, receipts, stock on hand, new replenishment order, stock on order, available stock, stock adjustment order, and order point, for four products to illustrate the effects on inventories of variations in lead times and of order-quantity rules. These records also were used to demonstrate a simple, direct way of periodically adjusting the order point to reflect any changes in demand apparent in sales.

Computers and Inventions Banquet Fare

The use of electronic computers will keep America out of business recessions, predicted Arthur B. Bronwell, president of Worcester Polytechnic Institute.

Mr. Bronwell was toastmaster at the banquet. He said, "When we know more about our economic system, we may be able to help control it through the use of computers.

"I think the time is coming when a mathematic computer and an economic specialist will be invaluable in making recommendations which would lead to economic stability instead of our present instability which has produced the current recession."

We do not know enough about our own economic system to be able to fabricate a workable mathematical statement describing it, he added.

AVAILABILITY LIST: PRODUCTION ENGINEERING CONFERENCE PAPERS

THE papers in this list are available in separate copy form until Feb. 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers.

Paper No.	Title and Author
58—PROD-1	Automatology Applied to Data Processing, by A. F. Maynard
58—PROD-2	Examples of Re-order Control Systems, by R. G. Brown
58—PROD-3	A Proposed Data-Processing System for Control of a Job-Shop Machine Floor, by W. R. Elmendorf
58—PROD-4	Cut Inventories—Cut Stock Outs, by N. V. Reinfeld
58—PROD-5	A System for Computer Control of Production and Inventory, by J. E. Haynes
58—PROD-6	The Computer in Job-Shop Production Control, by W. B. Pirnie, Jr.

inventory controls

It is remarkable, he stated, that the most retarded area in computer development was application to scientific and engineering problems.

"Someday a computer will be as common a tool as a slide rule," he predicted.

Norman A. Blodgett, a Worcester patent attorney, was after dinner speaker at the conference banquet.

Mr. Blodgett gave a slide-illustrated talk on patents which have been awarded for chocolate-covered chewing tobacco, a grave with an escape hatch and doorbell, a rubber stamp for quick application of lipstick, a combination plow and cannon invented for use against wild Indians, and fish lure which used mirrors to capitalize on belligerence and greed of male fish and the "well known" vanity of females of all species.

C. A. Read, 65-Year ASME Member, Honored

Prof. Carleton A. Read was presented with a membership pin and certificate denoting 65 years of continuous membership in the Society, at his home, by Charles E. Crede, Vice-President, ASME Region I.

Professor Read, who is 90 years old, retired from the faculty of Worcester Polytechnic Institute in 1934, after a long career as professor of steam engineering and superintendent of heat and power.

"I well remember the annual meetings of the Society in those days," said Professor Read recalling 1893. "The Society headquarters in those days used to be in a rented room in New York. If you didn't get to the meeting early, you couldn't tell who was there because the cigar smoke got so thick."

"One of the major projects which the new technical Society undertook was in the boiler field," said Professor Read referring to the boiler explosions so common in the latter part of the 19th century. "They studied the causes of explosions and prepared a code of standards which were designed to eliminate mechanical failure. Success didn't come overnight, but eventually the ASME Boiler Code was accepted as a standard throughout this country and in many parts of the world. The code is revised occasionally as the need arises and it is still the standard followed by boiler makers and insurance companies."

C. A. Read, retired, WPI professor, steam engineering, presented 65-year membership certificate by C. E. Crede. Mrs. Read admires certificate.

1959 Conference

The 1959 Production Engineering Conference will be held in Detroit, Mich., May 12–14, at the Hotel Statler.

ASME COMING EVENTS

June 9–12
ASME Materials Handling Conference, Cleveland Auditorium, Cleveland, Ohio

June 11–14
Third U. S. Congress of Theoretical and Applied Mechanics, Brown University, Providence, R. I. (ASME is cosponsor.)

June 15–19
ASME Semi-Annual Meeting, Hotel Statler, Detroit, Mich.

August 18–21
ASME-AIChE Heat Transfer Conference, Edgewater Beach Hotel, Chicago, Ill.

September 4–5
ASME Second International Congress on Air Pollution, Hotel Statler, New York, N.Y.

September 8–9
ASME Applied Mechanics Western Conference, University of California, Los Angeles, Calif.

September 15–17
ASME Process Industries Conference, Hotel Statler, Buffalo, N. Y.

September 21–24
ASME Petroleum Mechanical Engineering Conference, Cosmopolitan Hotel, Denver, Colo.

September 28–October 1
ASME Power Conference, Hotel Statler, Boston, Mass.

October 9–10
ASME-AIME Fuels Conference, Hotel Champlain, Old Point Comfort, Va.

October 13–15
ASME-ASLE Lubrication Conference, Hotel Statler, Los Angeles, Calif.

November 30–December 5
ASME Annual Meeting, Hotels Statler and Sheraton-McAlpin, New York, N. Y.

April 13–15, 1959
ASME Hydraulics Conference, University of Michigan, Ann Arbor, Mich.

April 19–23, 1958
ASME Oil and Gas Power Conference, Shamrock Hilton Hotel, Houston, Texas

April 23–24, 1959
ASME Management-SAM Conference, Hotel Statler, New York, N. Y.

Note: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

(For Meetings of Other Societies, see page 126)

Design Conference and Show Held at Chicago's Amphitheatre

18,000 Attend the Exhibit of Design Engineering, the Art in Which America Stands Pre-eminent. 1100 Engineers Meet at Technical Sessions.

CALL it design engineering. Call it the creative expression of mechanical know-how. It's the thing we do better—certainly more—than any other nation. It is the American art.

During four days, April 14–17, 1958, the Machine Design Division of The American Society of Mechanical Engineers held its annual Conference in Chicago at the International Amphitheatre near the stockyards. The meeting, sponsored jointly with the ASME's Chicago Section, drew just under 1100 engineers to four arenas to hear and discuss technical papers. Concurrently, the annual Design Engineering Show drew 18,000 men of the trade to the Amphitheatre to see design engineering on display. There were some 400 booths with exhibits worth more than $10 million.

Editors Provide Leadership

As in past years, editors of magazines devoted to the mechanical and electrical arts served importantly in the planning and execution of the design conference. At the first technical sessions, Monday, April 14, the chairmen were: G. F. Nordenholt, former editor of *Product Engineering;* Colin Carmichael, editor of *Machine Design;* H. R. Clauser, editor of *Materials in Design Engineering;* and F. J. Oliver, editor of *Electrical Manufacturing.* All are members of the ASME, and all have given service and leadership to the Machine Design Division.

Papers presented at the first day's sessions came from American Machine and Foundry, Sheffield Corporation (Autometrology Division), Picatinny Arsenal (Plastic Materials Unit), General Electric, Cincinnati Milling Machine Company, and Vickers, Inc. There was also a question-and-answer panel session, with panel members from Stewart-Warner, Westinghouse, Fairbanks Morse, and Link Belt.

On succeeding days, Armour Research, New Jersey Machine Corporation, Texaco, General Motors, Wright Air Force Base, Giddings & Lewis, and General Electric were sources of technical papers. Rapid advances were reported in new materials, plastics, and the "sandwich" designs in which honeycombs of steel offer a partial solution to the problem of lightweight structures for high-speed aircraft, where heat precludes the use of aluminum.

The Trend in Research

A trend brought out during the panel discussion was the transfer of the research burden to independent laboratories. Even large firms are finding they can have new materials and new parts tested by independent research centers more economically than by increasing their own laboratory facilities. The tendency is to limit company testing to the quality control of the finished product.

Technical papers were expanded at each session. Long and enthusiastic question periods followed each paper, due in part to the system inaugurated by the Machine Design Division last year. Everybody in the audience is provided with "question cards," and they write their questions—or points of argument—on cards which are immediately handed to the session aides, who take them at once to the vice-chairman. By the time the presentation of the paper has been completed, the chairman and vice-chairman have organized the discussion that is to follow, and questions are read from the platform. It worked successfully in the heavily attended sessions.

Saddle and Sirloin Club

In the dining hall of the Saddle and Sirloin Club, the Division held its luncheon, the feature social event of the conference. The Club occupies part of

the third floor of the Stock Yard Inn, a hostelry rich with the flavor of the Southwest. More than 250 engineers sat down to lunch in the high-ceilinged room with its mammoth wooden beams and its walls solid with paintings of men who have served Chicago and the cattle empire. An Easterner recognizes a few portraits, such as Charles G. Dawes with his characteristic pipe.

H. S. Sizer of Brown and Sharpe, who is chairman of the Machine Design Division, made the introductions, and conveyed the Division's thanks to the editors who had taken the responsibility for the technical papers.

The main speaker, John T. Rettaliata, Mem. ASME, president of the Illinois Institute of Technology, was introduced by R. S. Stover, Vice-President, ASME Region VI. Mr. Stover reminded the audience that Dr. Rettaliata had once held the same office for Region VI following his earlier work for the ASME as a proponent of the Gas Turbine Power Division for which he served as chairman in 1947–1948.

The Essential Ingredient

In his speech, Dr. Rettaliata offered a number of long-range observations on the future of design engineering.

"Creativeness," he said, "is the essential ingredient in your work. Out of it come the marvelous machines which give our people the highest standard of living ever enjoyed by man." . . . (and) "the most nearly classless society ever known."

After outlining the tremendous growth he foresees for this country, he said, "The realization (of this economy) . . . will require further advances in all the techniques of automation, electronic computers, motion study, materials handling, operations research, and many more yet to be devised."

To make this future a reality, he said, we shall need more engineering graduates. He reported there had been improvement, an increase of 17.8 per cent in 1957 over 1956. But estimates indicate there will be a continuing shortage, averaging about 8000 a year for the next decade. By 1970, approximately 70,000 engineers should be graduated each year, but the need will still exceed the supply.

He added: "If we as a nation are to attain the stature of which we are capable, we may have to improve our methods of rewarding the creative impulse. Individuals and organizations are most productive when there is a stimulus to research and invention."

A newsworthy item in Dr. Retalliata's speech was his recommendation that more women be encouraged to enter the engineering profession.

"Only one and one-quarter per cent of the profession are women," he said. "This is less than the proportion in each of the professions of law, college teaching, journalism, and medicine. Currently, only one half of one per cent of engineering college students are women."

The Big Top

The Design Engineering Show, produced by the New York firm of Clapp and Poliak, Inc., placed the latest products of our creative engineering before manufacturers and designers from 15 countries. This was the third, and the biggest, of the design expositions, the first two having been staged in Philadelphia and New York.

Not only did it present the essence of this country's progress: The show was America in a very special way, in that little of a military nature appeared. This was peaceful engineering, the new devices, new methods, new materials developed to make better machinery for better living and for more profitable industry.

Examples: All-plastic truck bodies; decorative screens which radiate heat from printed circuits; chain couplings with nylon elements; ingenius new mechanical speed-reduction devices; hydraulic controls that govern the automatic operation of machine tools within a ten-thousandth of an inch; plastic trims to simulate chrome, brass, copper; glass ball bearings (for their heat-resistant qualities); roller bearings "fractured" for assembly; building materials to color the skylines of major cities. Twelve thousand products on brilliant display in a giant showcase.

In the period of three years, the Design Engineering Show has grown to a position among the three largest annual industrial expositions in the country.

AVAILABILITY LIST: MACHINE DESIGN CONFERENCE PAPERS

THE papers in this list are available in separate copy form until Feb. 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents to members; 50 cents to nonmembers.

Paper No.	Title and Author
58—MD-1	Mechanical Memory Devices, by Arthur Mirel
58—MD-2	Automatic Inspection Devices, by D. H. McConnell
58—MD-3	Effect of Rate on Tensile Properties of Plastics, by G. R. Rugger, E. McAbee, and M. Chmura
58—MD-4	Uncommon Engineering Metals, by J. P. Denny and L. F. Kendall, Jr.
58—MD-5	Electrohydraulic Applications to Machine Tools, by A. H. Dall and E. J. Rivoira
58—MD-6	Current Design Practices in Electrohydraulic Control Systems for Airborne Aircraft and Ground Applications, by F. L. Moncher and L. D. Taylor
58—MD-7	Problems in Automatic Machinery, by M. J. Faltot
58—MD-8	Lubricant Considerations in Centralized Systems, by R. D. Skoglund and R. K. Gould
58—MD-9	Compatability of Metals in Bearing Contact, by C. L. Goodzeit
58—MD-10	High-Strength Structural Sandwich Construction, by W. E. Dirkes
58—MD-11	Integrating Mechanical and Electrical Design in Servo Systems, by W. L. McCann
58—MD-12	Integration of Mechanical and Electrical Design in Servo Systems, by G. G. Ertell
58—MD-13	The Information Center of Tomorrow, by Allen Kent and J. W. Perry
58—MD-14	A Central Catalog File Saves Engineering Time and Money, by J. L. Dykes

ASME Metals Engineering Division Takes Part in AWS 39th Annual Meeting in St. Louis

Technical sessions and Welding Show attract large audiences

Man behind mask, AWS President G. O. Hoglund, cuts aluminum chain to signal opening of sixth Welding Show in St. Louis

The Metals Engineering Division of The American Society of Mechanical Engineers joined with the American Welding Society to make the week of April 14 in St. Louis, Mo., truly a "Welding Week."

Registration for the technical sessions, held at the Hotel Statler, reached the official number of 1389 while more than 8000 saw the largest Welding Show ever gathered under one roof at Kiel Auditorium. This technical meeting and welding show attracted the most expert knowledge in the field. New techniques, processes, and developments were revealed and apparatus examined.

ASME Co-operates in Program

During the week-long technical meeting a total of 63 papers was presented at 21 technical sessions by 95 authors from all parts of the United States and Canada. Some of the papers attracted audiences of close to 400 persons.

Seventeen of the technical sessions were held under the sponsorship of the American Welding Society. Coverage was given to such subjects as steel weldability and research; designing for welding; welding arcs and heat flow; resistance welding; aluminum and magnesium; titanium; uranium, titanium and high-nickel alloys; brazing; welded structures; gas-shielded welding; submerged-arc welding; and application, equipment, and inspection.

The ASME Metals Engineering Division co-operated with AWS in the sponsorship of four additional technical sessions. These dealt with such topics as strength of welds; mating of structural properties with design; design and material for low-temperature application; and casting weldments.

The opening ASME-sponsored session on Tuesday morning was addressed by James N. Landis, ASME President, who noted the fine co-operation between the two societies and expressed a desire for a continued amiable relationship.

Educational Lecture Series

Prof. Earl M. Parker, University of California, explained the "Engineering Behavior of Welded Structures," at the Educational Lecture Series presented on Monday and Tuesday afternoons. This activity, and others of a similar nature, are sponsored by AWS Educational Activities Committee.

At another meeting, J. H. Humberstone, president, Air Reduction Sales Company, and R. D. Stout, head, Metallurgical-Engineering Department, Lehigh University, spoke on the need for educational expansion and improvement in the welding industry.

Also on Tuesday afternoon, an informal panel discussion was held in Kiel Auditorium on "Practical Shop Operations." Ted Jefferson, editor of *Welding Engineer*, served as chairman of the panel.

E. F. Nippes Adams Lecturer

Ernest F. Nippes, professor of metallurgical engineering and director of welding research at Rensselaer Polytechnic Institute, was the Adams Lecturer at the opening session. He spoke on "The Weld Heat-Affected Zone." The honor of presenting the Adams Lecture is bestowed annually upon an outstanding scientist or engineer who has made a valuable contribution to the field of welding. Dr. Nippes explained that his topic has been prompted by the keen interest exhibited by the welding laboratory men at RPI in the effect of weld thermal cycles on the microstructure and mechanical behavior of base metal in the heat-affected zones. He described apparatus which had been developed to permit exact duplication of any weld thermal cycle in a specimen of suitable size for subsequent mechanical testing. Also, he emphasized the advantage of this approach—the ability to create finite volumes of any particular weld heat-affected zone structure at will, thus permitting careful study of the microstructural changes produced by welding and correlation of such changes with physical and mechanical behavior.

Banquet

Relaxation was in order on Monday evening at the traditional AWS President's Reception. Here the usual, pleasant custom of meeting new friends and

Book publisher Bennett Cerf of Random House, New York City, and TV panelist on "What's My Line," gives a talk on "Changing Styles in American Humor" before a large and interested audience at banquet. Mr. Cerf also is president of Modern Library, Inc., which he founded in 1925.

View shows the crowds beginning to pour into the registration area as engineers gather at Hotel Statler, St. Lous, Mo., for the welding conference and show

E. F. Nippes, *right,* of Rensselaer Polytechnic Institute, receives 1958 Adams Lecture Certificate from C. P. Sanders, 1957–1958 AWS president. Professor Nippes chose for his topic "The Weld Heat-Affected Zone."

W. L. Fleischmann, ASME Co-ordination Committee, addresses Strength of Weld Session. ASME Metals Engineering Division sponsored four technical sessions.

the renewal of old acquaintances was enjoyed by more than 600 guests. Immediately following the reception, the banquet was held in the Grand Ballroom. Featured at the affair were two humorists who entertained the large audience. A. Carl Weber served as toastmaster on this occasion to the delight of the group. He was followed by the nationally known Bennett Cerf, who deviated from his talk on "Changing Styles in American Humor" long enough to note that "following Colonel Weber was like following Bob Hope." Mr. Cerf, publisher of Random House and TV panelist on "What's My Line," pointed out the worth-while effect a number of American humorists have made on the international scene.

Inspection Trips

Nearly 400 persons took advantage of the excellent plant tours arranged by the committee. The Wednesday group journeyed to the A. O. Smith Corporation plant in Granite City, Ill., to see the mass-production assembly line of the new all-welded Chevrolet automobile body frame. The Midwest Piping Company plant, St. Louis, Mo., major fabricators of pressure and process piping for all industrial applications, was visited on Thursday morning. Here the visitors witnessed, among other things, the fabrication of a low-alloy steel piping with an OD of 22 in. and a wall thickness of 4 in. This is considered to be one of the heaviest wall pipings for steam service ever fabricated.

Sixth Welding Show

G. O. Hoglund, AWS president during the colorful ceremony at Kiel Auditorium, on Tuesday morning, expertly cut the aluminum chain to mark the official opening of the sixth annual Welding show. Valued at $2\frac{1}{2}$ million, the 128-company display in the auditorium covered more than 33,000 sq ft of floor space. Official registrations for the show totaled 8743. Not included in this tally were a thousand or more from the area, namely, students from the city's universities, vocational, trade, and high schools. The continuous flow of interested spectators toured the exhibits to see the latest advances in the art of welding. Many of the booths contained live exhibits, encompassing practically every facet of welding and its allied processes. One corner of the exhibit hall was devoted to welded products of manufacturers in the St. Louis area.

AVAILABILITY LIST: METALS ENGINEERING CONFERENCE PAPERS

The papers in this list are available in separate copy form until Feb. 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents to members; 50 cents to nonmembers.

Paper No. Title and Author

58—MET-1 Design Values for Thermal Stress in Ductile Materials, by B. F. Langer

58—MET-2 Design of a Thin-Walled Cylindrical Pressure Vessel Based Upon the Plastic Range and Considering Anisotropy, by J. Marin and M. G. Sharma

58—MET-3 Properties Affecting Suitability of Nine Per Cent Nickel Steel for Low-Temperature Service, by T. N. Armstrong, J. H. Gross, and R. E. Brien

58—MET-4 Welding Low-Alloy Steel Casting. . .For High-Pressure and High-Temperature Service, by N. A. Chapin, C. H. Soldan, and L. W. Songer

58—MET-5 Casting-Weldments in a Petroleum Refinery, by J. Bland, C. B. Parrish, and R. C. Wheeler

58—MET-6 Co-operative Investigation of a New Welding Electrode for Stainless Steel, by R. D. Wylie

58—MET-7 Welding Metallurgy of Cr-Mo-V Steels for High-Temperature Steam-Turbine Components, by R. J. Christoffel, R. M. Curran, F. H. Domina, and C. H. Soldan

58—MET-8 Welding Qualification and Component Performance, by W. L. Fleischmann

58—MET-9 Pressure Equipment for Low-Temperature Service, by C. R. Soderberg, Jr.

58—MET-10 Welding Cast Components for Nuclear Power Application, by W. H. Rice

Dirt, rail adhesion, lading damage, aluminum freight cars, among the topics of the . . .

ASME-AIEE Railroad Conference

Holcombe Parkes, president of the Railway Progress Institute, asks for organized statesmanship

Session chairmen: E. Crankshaw, Mem. ASME, chief engineer, Cleveland Graphite Bronze Company, and J. S. Ingles, Assoc. Mem. ASME, chief mechanical engineer, Detroit, Toledo & Ironton RR

CONSIDERATION of several major technical problems that affect all types of railroad motive power, some good advice, much good humor, and a side glance at the U. S. Missile Program were among the ingredients of the joint Railroad Conference sponsored by the Railroad Division of The American Society of Mechanical Engineers and the Land Transportation Committee of the American Institute of Electrical Engineers with the co-operation of the Cleveland Sections of both organizations. A total of 244 registered for the sessions held April 9 and 10 at the Hotel Statler in Cleveland, Ohio.

Technical Sessions

The methods of coping with the problems of dirt and rail adhesion were the two principal topics of the papers presented at the technical sessions. About 25 cents of every maintenance dollar is spent removing dirt or repairing the damage done by it. The problem extends from the trouble caused with electrical equipment to the wear caused by improper lubrication and improper filtration of lubricating oil. Cleaning has been a byword in locomotive operation, but present labor costs make an overcleaned locomotive a luxury that few railroads can afford. Establishing the practical and economic limitations of cleaning operations are desirable objectives for any type of motive power, and the details of one program for diesel-electric locomotives were presented.

Dirt. Air filtration has become increasingly important in the control of the dirt admitted to engine rooms. Some experiments have been made with pressurized cabins to prevent air from being forced into the compartment by the motion of the train. Sealing of body cracks and other areas of admission as well as the application of some of the principles of aerodynamics to the design of locomotives could do much. Not only is air drawn in in great quantities and at high speeds but brings with it all of the debris that collects along the right of way. Some work is being done with electrostatic precipitation on the air intake.

Rail Adhesion. Methods of improving rail adhesion by treatment of the track, although effective, leave much to be desired. An altogether different approach has been taken as far as slippage during braking is concerned. A study proved that skid stops are not only uncomfortable for passengers and hard on equipment but require a greater distance than when the brakeage is kept as near the maximum without wheel slippage as possible. The incorporation of a slip-sensing device into each brake has yielded a design which accomplishes the shortest possible step by as many as 22 automatic detections and corrections in a single stop.

Lading Damage. Lading damage in freight cars was the subject of two papers. One was an analysis of vibration and shock as the cause of such damage. A practical method of controlling the amplitude and acceleration of vibration resulting from the normal wavy track profile through softening of the spring suspension and the use of dynamic-vibration absorbers was presented. Suggestions were made for improving energy-absorbing mechanisms to minimize shock, particularly through greatly increased closure over that provided in present draft gears.

The second paper was a brief outline of the unique constructional features and manufacturing, operating, and maintenance experience with the Hydracushion car. A hydraulic buffer combined with a sliding-sill cushion-type underframe is the means of controlling the flux of energy to the car lading. There are now 350 of these cars designed by Stanford Research Institute in use, and they are regarded as a practical solution to the problem of lading damage due to longitudinal shock. No maintenance problems have developed.

Hot boxes are being eliminated with automatic lubrication systems that replace the waste-pack and lint system. The elimination of improper weight distribution, uneven end wear, and bearing-lining deformation can be overcome with means suggested in a study of the available and potential developments in design for standard AAR solid-bearing assemblies.

Aluminum open hopper cars tested in impacts at collision speeds have demonstrated that aluminum has high impact resistance suiting it to freight-car applications. Thirty cars incorporating information gained from these tests made by Aluminum Laboratories Limited and sponsored by the Aluminum Company of Canada, Ltd., have already been designed and built for Canadian railways and more are on order.

Good humor was in evidence in the exchange of opinions that took place when Harry F. Brown of Gibbs & Hill sug-

at Cleveland

ASME President J. N. Landis looks on as luncheon speaker Wilson Hunter, assistant to director, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio, explains some of the objectives and engineering significance of missile program

gested that the reduced-maintenance superiority of diesel power over steam might be a statistical fallacy. He emphasized that the average age of diesel equipment was considerably less than that of steam, and it will be some years before the "old-age" characteristics of this equipment will be known. He suggested that a good look was in order and that it was unfortunate that the diesel had virtually eliminated what might be a more economical power source if it were given the benefits of modern design.

Humor reached its high point in the account R. E. Swanson gave of the Pacific Great Eastern Railroad. It was formerly known as the railroad from nowhere to nowhere, since it began a mountain range away from Vancouver, B. C., and ended at Quesnel about 20 miles from the small town of Prince George, one of the farthest north outposts of the Province. Since there were no highways in the area and people had been induced to settle there by the building of the railroad, the provincial government had operated the line at a loss for a good many years. To celebrate the Province's 100th anniversary as a part of Canada, it was decided to complete the railroad. This was done at a cost of $100 million with some unusual engineering problems. Mud Mountain and Cottonwood Canyon were two points that had defeated all attempts to complete the railroad. Recent glaciation of the area had left an unconsolidated soil that caused bridges and right of way to slide downhill soon after they were constructed. The road was finally completed giving it main-line connections at both ends as well as topping the greatest bull-shipping country in North America. Diesel service with radiotelephone communication, in place of more expensive communication systems, and airplane-style dining service, lacking only the "fasten seat belts" injunction, have converted a former joke into a modern railroad.

Banquet and Luncheons

Curtis Lee Smith, president, Cleveland Chamber of Commerce, was the toastmaster at the banquet. E. M. Whanger, special assistant to the vice-president of operations, Chesapeake & Ohio Railroad, showed colored slides of his trip through Scandinavia which included some pictures of railroads.

F. L. Murphy, chairman, ASME Railroad Division, was toastmaster at the luncheon on Wednesday. Willson H. Hunter, assistant to the director, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio, talked on "Missiles, Satellites, and What's Beyond."

He emphasized the engineering accomplishments which the various missiles and aircraft represented, and stressed the planning difficulties for a program in which the product is usually obsolete by the time it is in operation.

Replying to questions on the comparative advancement of the United States and Russia on artificial-satellite development, and the significance of the larger size of the Russian versions, he stated that we have done a far superior job of instrumentation. The miniaturization of the control instruments and data-gathering has been so successful that we get more data from our tiny satellites than they do from the huge ones.

Mr. Hunter pointed out that he did not wish to minimize Russia's accomplishments, because they were of great importance, but the puzzling failure to release any significant scientific data can lead only to the assumption that their findings have been insignificant.

Holcombe Parkes, president, Railway Progress Institute, was the speaker at the Thursday luncheon. P. G. Lessmann, vice-chairman, Land Transportation Committee of the AIEE, was toast-master. Mr. Parkes stated that, since he had been instructed to "provide a change of pace" from the highly technical sessions of the conference, his talk was going to suggest a change of pace for the railroad industry as well.

He noted the old grade-crossing insignia which stated "Stop, Look, and Listen!" would be a good summary of what he had to say. The railroads are facing government ownership, and it is time to bring about some changed attitudes. The industry needs pride in its accomplishments and to stop talking about "my railroad," and to speak of "the railroad." Some way must be found to get organized statesmanship out of railroad employees. Faith, hope, courage, and determination are needed as well as understanding of the business of railroading if the industry is to survive. When railroad men become convinced of the importance of their industry, its value to the country, and the value of private ownership, then they will be able to convince others by their own convictions.

AVAILABILITY LIST: RAILROAD PAPERS

The papers in this list are available in separate copy form until Feb. 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers.

Paper No.	Title and Author
58—RR-1	Aluminum in Rolling Stock Impact Tests at Collision Speeds, by R. A. Campbell, J. G. Sutherland, J. F. Whiting, and R. A. Kemp
58—RR-2	The Hydracushion Car, by W. K. MacCurdy and R. M. Hermes
58—RR-3	Available and Potential Developments in Design for Standard AAR Solid-Bearing Assemblies, by M. A. Hanson
58—RR-4	Vibration and Shock in Freight Cars as Causes of Lading Damage, by J. C. Settles

ASME'S Newest Division Holds First Technical Conference

Maintenance and Plant Engineering Division makes successful debut at Pittsburgh

On April 14–15, 1958, the city of Pittsburgh, Pa., saw the debut of the Maintenance and Plant Engineering Division of The American Society of Mechanical Engineers. The new Division, which had received its charter only two months previously, held its first conference at the steel center's Penn Sheraton Hotel. A gratifyingly large number of maintenance and plant engineers—more than 200—gathered at Pittsburgh for technical sessions, social events, and a field trip.

Feet on the Ground

In this age of rockets and nuclear power, it is notable that the Society's newest Division is strictly down to earth. Senior engineers, long away from the higher mathematics, found themselves at home, both with the subject matter and with their fellow conferees. These are the men who decide how our industrial plants shall be built and equipped for efficiency, reliability, and low maintenance, and who keep those plants working. They make the wheels turn.

The conference, sponsored by the Division and the ASME's Pittsburgh Section, in co-operation with the American Institute of Plant Engineering and the Plant Engineers' Association of Greater Pittsburgh, presented three technical sessions and a field trip to a U. S. Steel plant. There was a luncheon at which C. J. Zetler, Jr., of Westinghouse reported on the relation of plant engineering to management costs, and a banquet at which ASME's President J. N. Landis—he is vice-president of Bechtel Corporation—spoke on the mechanical engineers' role in plant engineering and maintenance.

President Landis pointed out that the interests of the new Division cut across those of other divisions of the Society, since plant engineering enters into design, manufacture, and operation. Spelling out the functions covered by the division, he said:

"Plant engineering includes design, procurement, and installation of all new buildings and equipment as well as changes to existing plant. It includes furnishing utility services such as electricity, steam, water, gas, and compressed air required for production. It includes the management of industrial wastes, and the salvage and disposal of obsolete and scrap equipment. It must establish and direct its own organization to carry out these functions."

"The Division," he said, "must encourage and foster research and development and the publication of significant data within the scope of these activities." . . . (It must) "co-operate with other agencies, both inside and outside the Society, in respect to standardization, research, preparation of papers, meetings, and special services, and in the avoidance of duplication of effort, and conflicts." . . . (It must) "direct attention to outstanding achievement in the field of plant engineering, and recommend suitable recognition for achievement."

This statement of objectives, directed at the fledgling Division, would give a newcomer an understanding of the purposes of the whole of The American Society of Mechanical Engineers.

The New Pittsburgh

Engineers visiting Pittsburgh for the first time in many years found it a changed city, a clean metropolis of modern architecture and first-rate highway approaches. To travelers from some other cities, the airport building could bring the green of envy—depending, partly, on the double feature at the theater. Does your air terminal include a theater?

At 9:30 Monday morning, April 14, the technical sessions began. Guerard Mackey of du Pont, the Division's first Executive Committee chairman, made the speech of welcome. A check of the

Left: **C. J. Zetler, Jr., Mem. ASME, talks at Conference luncheon**

The Forum, *left to right,* J. D. Quinn, Mem. ASME, chairman; J. D. Drucker, Mem. ASME; O. W. Gravely, W. E. Chandler, R. W. Hiller, tackled questions brought up at sessions

first day's registration indicated he had before him engineers from 19 states who had come to review and discuss the technical papers.

H. W. Shockley, a maintenance consultant of Wilmington, Del., presented the Division's first paper, on "Engineering Maintenance—A Tool of Management." During the morning session, other papers emanated from Continental Diamond Fiber Company (a division of Budd Company of Newark, Del.) and from du Pont. In the afternoon session, papers came from du Pont and Stewart-Warner.

On Tuesday, April 15, the conference held a maintenance forum with agenda based on topics suggested in writing by the conferees. The forum consisted of members from Electro Metallurgical Company (Union Carbide), Monsanto Chemical, Dravo Corporation, and U. S. Steel.

Over the Luncheon Table

At the luncheon, held on Monday, more than 100 conferees heard C. J. Zetler, Jr., an ASME Committeeman who is plant engineer with Westinghouse at East Pittsburgh. Mr. Zetler spoke as a proponent of formal programs of maintenance carried out in a scheduled way.

The planning of plant expansion, the maintaining of good power factor on the plant electrical system, and the alert monitoring of the heating system were specific examples taken up. He reported saving 20 per cent in the total heat input at his plant by close control. The use and disposal of plant water are becoming complex: Water is no longer cheap. Police, fire, and telephone systems can be studied in relation to the insurance requirements. The telephone system may serve for fire and plant protection at lower cost than a separate system. In Mr. Zetler's plant, the Maintenance Department trouble shooters have been motorized, with a central desk for dispatching. These are a few of the procedures, the "managed costs," controlled by the plant engineer.

Mr. Zetler said: "There is no operation being performed in industry which cannot be done better. If we wait for others to find new methods, we are going to fall behind. Meetings of the type we are having here should be part of every plant engineer's life."

On the second afternoon, two buses were filled with men making the field trip to the Homestead Works of the U. S. Steel Company at Munhall, Pa. The trip included inspection of Maintenance Shop facilities, open hearth furnaces, and rolling mills. Returning, the party saw such points of interest as Carnegie Institute of Technology, University of Pittsburgh, Carnegie Library, Mellon Institute for Industrial Research.

Assignment to Plant Engineering

At the banquet—Guerard Mackey presiding—President Landis presented his views on the work of this group by reading a report called "Reflections and Actions of an Old Mechanical-Engineering Hand When Assigned to Manage the Maintenance and Plant Engineering Department of his Company." Mr. Landis assured the gathering that this account was largely fictitious, though he had, indeed, dealt with maintenance at one time. The "report" told of the career of a plant engineer as Mr. Landis felt it might and should be experienced, a sequence of events likely to be realized with increasing frequency.

He made incidental mention of a visit to the Esso refinery at Baton Rouge—"One of the cleanest and most colorfully painted plants I've ever seen."—where, in spite of the climate, their maintenance is performed under such conditions that "I'm sure the workmen in this shop must hate to go home at quitting time." He urged that the Division try to hold a meeting some time at Baton Rouge.

Mr. Landis, speaking of the national role of the ASME, paid special tribute to Ernst W. Allardt, Vice-President of the Society's Region V, who "makes the trip to New York City each month to sit on the Executive Committee of the Council. I very much respect Mr. Allardt's zeal and work for all of you and for the Society at large."

AVAILABILITY LIST: MAINTENANCE AND PLANT ENGINEERING CONFERENCE PAPERS

The papers in this list are available in separate copy form until Feb. 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents to members; 50 cents to nonmembers.

Paper No.	Title and Author
58—MPE-1	An Engineering Approach to Optimum Maintenance Stores, by R. E. Bley
58—MPE-2	Optical Tooling and Its Uses in Industrial Plants, by J. L. Hanold and H. R. Osmick
58—MPE-3	Development of a Basic Maintenance-Control System, by S. G. Hallett, Jr.
58—MPE-4	Engineered Maintenance as a Tool of Management, by H. W. Shockley
58—MPE-5	A Practical Approach to Vibration and Balancing Problems in Machine Maintenance, by R. T. Buscarello

BPI (*Continued from page 129*)

Doctor of Laws degree was conferred upon Mayor Robert Wagner of New York City, S. Marion Tucker, retired professor of English at Brooklyn Polytechnic, and Bishop Herbert G. Welch, 96-year-old Methodist Bishop-Emeritus of Japan and Brooklyn Polytechnic's oldest alumnus.

A plaque dedicating the new building was unveiled by Mrs. Grace Larsen Rogers and Preston R. Bassett. Mrs. Rogers is the widow of Dr. Harry S. Rogers, Mem. ASME, former president of the institute for whom the new building is named. Mr. Bassett is chairman of the board of trustees. Dr. Livingston W. Houston, Mem. ASME, president-emeritus of Rensselaer Polytechnic Intitute, eulogized Dr. Rogers, who died last year.

Two 10-ft murals, symbolizing "Science" and "Engineering," fabricated from Plexiglas, provide a unique architectural treatment of the entrance to the newly dedicated building of the Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Designed by the noted artist and muralist, Abraham Joel Tobias, at the laboratory of the Rohm & Haas Company, they represent the evolution of a new mural technique.

Management, Engineers, and Workers Appraise Cost Reduction

SAM-ASME Management Engineering Conference, Hotel Statler, New York, N. Y., April 24-25

ARE you making your cost reduction pay off? The response of a group, talented and experienced in the ways of cost reduction, was not "yes" and it was not "no." It was instead "how to." How to make cost reduction pay off in mutual benefits for management, the industrial engineer, and finally, the worker.

The group (about 500) met at the Management Engineering Conference at the Hotel Statler, New York, N. Y., April 24–25, 1958. The American Society of Mechanical Engineers in co-operation with the Society for the Advancement of Management sponsored the annual conference.

The "how to" does not take the form of a simple $ax + b = c$ equation. It is a combination of complex equations each having many variables and many factors, and complicated further by the human element which remains numerically undefined.

In the area of cost reduction, however, tools and techniques are being made available for the solution of such complex problems. New techniques in industrial engineering are making inroads into areas where possible solutions will be found. J. S. Sayer, Mem. ASME, E. I. du Pont de Nemours, Wilmington, Del., described a study in the application of the industrial-engineering techniques for improved performance of the technical-engineering function. The concept is based on the application of acceptable criteria of organization performance and the required feedback of cost, time, and quality information to make such criteria workable decision aids.

Honor excellence, and we do. Robert G. Hess, *right, top and center photos,* presents ASME Fellow certificates to Arthur M. Perrin, *top left,* chairman, ASME Metropolitan Section; and Fenton B. Turck, *center photo, left,* chairman, ASME Finance Committee. *Bottom,* Dr. Lillian M. Gilbreth, Hon. Mem. ASME, chats with John L. Schwab, *left,* recipient of the Gilbreth Medal Award, as SAM National President Homer E. Lemken, *right,* looks on.

According to G. H. True, University of Notre Dame, South Bend, Ind., our country's greatest need is for new ideas. New techniques will result from the development of creativity in industrial engineers. "Change is constant," he said, and management must "separate the wisdom of the past from out-of-date ideas, prejudices, humbug, and bunk," in order to develop creative solutions to new and ever-changing problems.

That change is constant, was reiterated by Phil Carroll, Fellow ASME, Maplewood, N. J. Failure to recognize this fact and to make corrections which compensate for change in standard data is one of the pitfalls in building these data. For maximum utilization of the work-measurement dollar, it is necessary to avoid known pitfalls and others, for example, seeking simple solutions to complex problems; using wrong dimensions to measure variable elements; and assuming that conditions are static.

Work-measurement dollars were discussed further in connection with a method of analyzing the worth of various forms of work measurement. G. E. Kane, Lehigh University, Bethlehem, Pa., in considering the economics of predetermined times versus stop-watch times, dealt with such items as identification of cost incident to work measurement and the break-even point in terms of time and recovery of investment.

Measurement of nonrepetitive work presents special problems in work sampling. J. M. Allderige, Eastman Kodak Company, Rochester, N. Y., noted that there are certain situations in which the right decision isn't obvious and the wrong decision can disrupt a system or unnecessarily complicate a work-sampling study. While work sampling is a powerful measurement technique and some useful guides exist for using it efficiently in simple situations, these need to be amended for more complex situations.

Maintenance tasks comprise a large portion of nonrepetitive work and as such present particular cost-reduction problems. C. C. Winston, Ernst & Ernst, New York, N. Y., cited several case studies dealing with the development of standard times for maintenance tasks and the application of standards to achieve control of maintenance labor and costs.

Better utilization of indirect labor—people who do not perform work on each part or do not directly add value to a part—depends to a degree upon the ability to measure that work. The "how to" of measurement of manufacturing indirect labor and clerical labor also was discussed by W. C. Cooling, Englehard Industries, Inc., Newark, N. J., and E. W. Gardiner, Sears, Roebuck & Company, Boston, Mass., respectively.

Wage incentives are a powerful management tool to stimulate maximum productivity, minimum labor costs, and

increased employee earnings. The fundamentals and control of wage incentives were appraised by B. A. Moski, Yale & Towne Manufacturing Company, Philadelphia, Pa., who explained how to establish certain clear-cut approaches to the elimination of specific inequities. Multiple factor incentives were discussed by H. B. Brandt, Mem. ASME, Proctor & Gamble, Company, Cincinnati, Ohio, yet another "how to" in the cost-reduction equation.

Another tool for planned cost reduction is method engineering. On this subject, R. D. McLandress, General Motors Corporation, Detroit, Mich., said that this technique involves analysis of man-job relationships for the purpose of establishing the most economical use of manpower, materials, and facilities.

Given these multiple ways and means of cost reduction, it is left to consider the short versus the long-range objectives of such programs . . . "Human values must be paramount," said Ralph Presgrave, J. D. Woods & Gordon Ltd., Toronto, Canada. "The problem is to recognize them clearly, to weigh the long term against the short term, the big gain against the little gain, practicality against sentimentality."

It is in this realm that the proving and improving of industrial-engineering performance finds its greatest applications. J. L. Schwab, J. L. Schwab Associates, Bridgeport, Conn., pointed out that the industrial-engineering profession must be able to evaluate its actions in terms of past accomplishments and, even more importantly, be able to predict results and develop plans for future progress. How to measure industrial-engineering performance so that it pays off in cost reductions was described.

Granted that the industrial engineer develops creative solutions to complex problems using the skills of his profession, he must also be capable o' selling his ideas. How to demonstrate effectively to management that an idea can be developed into workable cost and manpower-saving results was outlined.

The position of the foreman and the worker in an industrial engineering scheme is significant. An industrial-engineering department will operate most efficiently when it becomes a true staff service to the foreman. To attain this end, it is necessary that each share the same goals and work in co-operation to achieve them. The foreman-industrial engineer relationship was discussed by R. T. Studer, the Warner & Swasey Company, Cleveland, Ohio.

A labor-union representative, David Lasser, International Union of Electrical, Radio & Machine Workers, AFL-CIO, Washington, D. C., called for an industrial-engineering approach that is not merely efficient, but effective. He urged that, although much effort is expended in developing new techniques, planning, measuring, and such, greater consideration should be given to the intangibles. An understanding of such factors—the worker's sense of fair play, his sense of security, his dignity as a worker, his creativeness on his job—ultimately determines the success or failure of a program which in all measurable respects seems basically sound.

Luncheon Talks

"A little sleep, a little slumber, a little folding of the hands to rest, and poverty will come upon you like a vagabond, and want like an armed man."—Proverbs, V, x. This was the text taken by J. B. Joynt, New York Central Railroad, New York, N. Y., in his luncheon speech on the problems facing education. In this area as well as in all others, we must ward off complacency and "learn to honor excellence . . . and scorn shoddiness."

One of the prime profits of our age's technological excellence has been time. ASME President, James N. Landis, in his luncheon talk delivered some of his thoughts on time and, with a novel twist, called for audience reaction and their thoughts on the subject. Four of those who came through with ideas were rewarded with a $5 cash prize. Maximum efficient utilization of time pays off.

Honor Excellence

Each of the participating societies took the occasion of the conference to honor excellence in the field of management engineering. The ASME presented Fellow Certificates to two members: Fenton B. Turck, chairman, ASME Finance Committee, and president, F. B. Turck & Company, Inc., New York, N. Y.; and Arthur M. Perrin, chairman, ASME Metropolitan Section, and president, National Conveyors Company, Inc., Fairview, N. J. The 1958 SAM Material Handling Award went to R. Frank Weber, consulting editor, *Modern Materials Handling*, Boston, Mass. J. L. Schwab of J. L. Schwab Associates, Bridgeport, Conn., received the Gilbreth Medal Award.

ASME Elects Five to Grade of Fellow Member

The American Society of Mechanical Engineers has honored five of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow, one must be an engineer with acknowledged engineering attainment, have 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and be a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men who were so honored for their outstanding contributions to their profession and to the Society are:

Ray Neel Benjamin

Ray Neel Benjamin, vice-president and chief engineer, Georgia Power Company, Atlanta, Ga., is an outstanding engineer serving the electric-utility industry in the South. He is recognized as a foremost authority on the design and construction of modern central station steam-electric generating plants and hydroelectric developments. He has been associated with the Georgia Power Company or one of its affiliates since 1919. Throughout his career he has devoted his varied talents to the design and construction of the company's hydroelectric and steam-electric generating facilities, transmission and distribution systems, substations, and other engineering activities. Since 1933, he has had responsible charge of the general design for all generating plants constructed by the company. The seven principal plants constructed by the company in this period have a total capacity of over one million kilowatts. As an electric-utility engineer, administrator, and executive, Mr. Benjamin has attained an enviable record. During World War I, he served with the U. S. Army Engineers and was honored for his distinctive service by award of the following decorations: French Croix de Guerre with Silver Star and Palm, Legion of Honor-Chevalier, Distinguished Service Cross, Purple Heart, and Victory Medal with four battle stars. He has served on the committee which drafted a new Heating and Ventilating Code which was adopted recently by the City of Atlanta, Ga. During 1955 and 1956, he served on the Study Committee of the Georgia Institute of Technology Task Force for Mechanical Engineering. He has participated extensively in Society activities on a local and national level.

He has served the Atlanta Section as a member of the Executive Committee, secretary, treasurer, vice-chairman, and chairman. In 1956, he served as a member of the ASME National Nominating Committee. He is a charter member of the Georgia Engineering Society and the Society of American Military Engineers. A registered engineer in the State of Georgia, he has had work published in the technical press.

John Harland Billings

JOHN HARLAND BILLINGS, professor and head of the department of mechanical engineering, Drexel Institute of Technology, Philadelphia, Pa., is recognized as a peer in engineering education. He has been at Drexel since 1919, and in 1944 and 1945 was acting dean of the engineering college there. Under his direction, the department of mechanical engineering at Drexel has expanded greatly, and has provided continually improving training and guidance for aspiring engineers. A specialist in kinematics, Professor Billings has been a lucid teacher in thermodynamics and internal-combustion engineering as well. He is well known in the consulting field and is responsible for directing work on important government projects. He has been an engineering consultant with the Bureau of Ships, USN; and gage production representative with the Imperial Munitions Board, Ottawa, Canada. Before joining the faculty at Drexel, Professor Billings had taught at the University of Toronto, The Johns Hopkins University, and the University of Missouri. Author of several textbooks, "Applied Kinematics," "Mechanics and Design of Machines," and "Advanced Machine Design," Professor Billings has also published many articles on machine design, kinematics, and education. A registered engineer in the State of Pennsylvania, he also holds membership in Tau Beta Pi, Pi Tau Sigma, and Phi Kappa Phi. He is a fellow of AAAS, and has been chairman of the middle-Atlantic section of SPEE. His services to the ASME include his activity as a member of the Executive Committee of the Philadelphia Section from 1924 to 1930; he successively was secretary-treasurer, vice-chairman, and chairman of that section.

Alfred John Ferretti

ALFRED JOHN FERRETTI, professor and head of the department of mechanical engineering, Northeastern University, Boston, Mass., with his deep interest in science and mathematics as well as in their applications to the solution of engineering problems has been an acknowledged leader in his field. Before joining the faculty of Northeastern University in 1918, he had been an instructor at the Massachusetts Institute of Technology and at The Franklin Institute. At Northeastern, he successively acted as instructor, assistant professor, professor, and head of the department, and in 1953, was acting dean of engineering. It was his task to implement the first graduate evening engineering school in the Boston area, and for two years he supervised its program. Since 1925, he has also acted as a consultant in the fields of refrigeration and materials for companies such as Avco Manufacturing Corporation, Boston Edison Company, and Lawson Machine Tool Company. A member of the American Society of Refrigeration Engineers, the American Society for Testing Materials, AAAS, and ASEE, he has been especially active in ASME. At the ASME Diamond Jubilee Meeting in Boston, he was presented with the 75th Anniversary Medal, which was awarded to the man who contributed most to the Boston Section. He had been secretary-treasurer of the Section from 1942 to 1948; and he was its chairman from 1948 to 1949. The National Nominating Committee received his services in 1950 and 1951. His other ASME activities include his work as the chairman of the Semi-Annual Meeting Committee; membership on the ECPD Guidance Committee. He is an honorary member of Pi Tau Sigma and Tau Beta Pi. His services to the community have included work for charitable organizations.

Albert Nolan Horne

ALBERT NOLAN HORNE, vice-president and general manager, Texaco-Cities Service Pipe Line Company, and Kaw Pipe Line Company, Tulsa, Okla., has supervised or in some way been connected with the design and construction of practically all of the world's largest oil pipeline systems. He was among the first to apply engineering principles to oil pipeline design, construction, and operation. He was active in the design of the first automatically operated unattended pumping station at a time when it was thought that such a project was not feasible. Prior to World War II, Mr. Horne was a principal member of the design engineering committee which recommended that a Big Inch pipeline be constructed to transport critically needed oil from Texas to the Eastern Seaboard. When the war began, he was relieved of his duties as a U. S. Army major in order that he might supervise design, construction, and operation of the 24-in. Big Inch crude-oil pipeline, and the 20-in. Little Big Inch products line. During this time, he was vice-president and assistant general manager, and later general manager of War Emergency Pipelines, Inc., Cincinnati, Ohio, which performed these services for the U. S. Government. With this project successfully completed, he was called upon to assume complete responsibility for the Trans-Arabian pipeline system, a combination 30–31 in. pipeline running through remote desert areas from the Persian Gulf to the Mediterranean Sea, which at the time was the largest pipeline undertaking in the world. He was responsible for the 450-mile Canadian refined products pipeline from Montreal to Toronto, Hamilton, and Ottawa. In his current position, Mr. Horne is the principal officer of both companies, and as such, is responsible for the operation, maintenance, and construction incidental to the successful operation of the Kaw System in Kansas, the Texas-Cities Service natural gas, liquids, and crude oil pipelines system from the Kansas-Oklahoma area to Chicago. In addition, he has acted as a consultant on a proposed 34–36 in. pipeline from Iran to the Mediterranean through Turkey, and from Iran to the Persian Gulf. Mr. Horne has been an active member of the following societies and professional groups: National Association of Corrosion Engineers, the American Petroleum Institute, and the American Institute of Electrical Engineers. He is currently a member of the ASME Mid-Continent Section Executive Committee and in 1932 served as its chairman. In 1957, he was a member of the Finance Committee for the Petroleum Division Conference.

Karl E. Peiler

KARL ERNEST PEILER, vice-president and consultant for research, development, and engineering, Hartford Empire Company, Division of Emhart Manufacturing Company, Hartford, Conn., is one of the foremost authorities in the art of glassmaking. His patents, almost 180, are adequate testimony to his inventiveness. Mr. Peiler began his studies of the glassware industry as an assistant engineer associated with the late William A. Lorenz, consulting engineer. His inventions were directed toward providing a better method of feeding molten glass at regular intervals from the mass in a melting furnace, and to shape them into desired forms. These efforts were realized in the development of the "Suspended Gob" feeder for molten glass. In 1912, The Hartford-Fairmont Company was organized for the purpose

of promoting Mr. Peiler's inventions and related equipment. The Peiler glass feeders are currently a standard means of feeding glass throughout the United States and in foreign countries. In 1922, the Hartford Empire Company was formed with Mr. Peiler as chief engineer; later he was vice-president and associate director of research. He assumed his present position in 1946. The National Association of Manufacturers awarded him its "Modern Pioneer" medal in 1940, "for distinguished achievement in the field of science and invention." Alfred University, in 1951, conferred on him an honorary DE degree. As a member of the Hartford Section of ASME, he served on its Executive Committee from 1928 to 1930, and from 1944 to 1950. He is also a fellow of the American Ceramic Society, and a member of the American Institute of Electrical Engineers, the American Chemical Society, and the Electrochemical Society.

PEOPLE

Honors and Awards. J. F. Downie Smith, Fellow ASME, research vice-president, Carrier Corporation, Syracuse, N. Y., has been named one of six honorary members of the Iowa Engineering Society. Dr. Smith has formerly been dean of engineering at Iowa State College.

Ben Moreel, chairman of the board, Jones & Laughlin Steel Corporation, was named the winner of the Washington Award. Mr. Moreel retired from active naval service with the permanent rank of admiral in 1946. The award is presented by the Western Society of Engineers on the recommendation of a commission representing ASCE, AIEE, AIME, and ASME.

Charles F. Kettering, Fellow ASME, director and research consultant, General Motors Corporation, was among seven persons honored as "great living Americans" by the United States Chamber of Commerce. The awards are made to American citizens "who, by their own initiative, self-reliance, and ambition, have made notable contributions to human progress."

Thomas K. Sherwood, Mem. ASME, retired dean of engineering, Massachusetts Institute of Technology, Cambridge, Mass., was among a group of 30 elected to the National Academy of Sciences at its annual meeting. Election to the academy is on the basis of distinguished achievements in research.

Nicholas J. Hoff, Mem. ASME, executive head, Aeronautical Engineering Division, Stanford University, has received an award of the Foundation for Instrumentation Education and Research, Inc., for aeronautical measurements research.

Automatic Techniques

(*Continued from page 133*)

The development of a logic diagram and algebraic description of a control system were the topic of a paper by J. P. Laird, Assoc. Mem. ASME, instrumentation consultant for E. I. du Pont de Nemours & Company. Part of the material appeared in Mechanical Engineering, January, 1958, pp. 38–41. Starting with a two-value system—"true" or "false," "on" or "off," "and" or "or," "zero" and "one," "x" and "not-x" it is possible to develop an algebraic or pictorial representation of complex systems that is sequential in nature. These not only eliminate some of the difficulties inherent in verbal description, but make possible the easy manipulation of a logic diagram to cancel double negatives or invert the "and" and "or" functions. The inversion technique is new and was described in some detail.

Victor Paschkis, Mem. ASME, director of the Heat Flow and Mass Analysis Laboratory at Columbia University, pointed out that "journalistic usage notwithstanding, computing machines are not 'thinking machines.'" They can only provide a numerical answer to one specific set of conditions, but this is sufficient to enable them to perform a number of functions of considerable use to engineers. They can evaluate a given mathematical expression, generalize a solution by the development of tables and graphs, determine the relative importance of variables, explore several concepts of a device, or scale up a process. To perform these functions, they require an adequate formulation of the problem in their "language" which represents a "dialect" of mathematics. Several "translations" may be necessary before the problem can be adequately stated.

Banquet and Inspection Trip

Magnus von Braun, manager, Redstone Program Control, Chrysler Corporation, Detroit, Mich., was the banquet speaker. He was introduced by T. H. Belcher, of the Michigan Bell Telephone Company, Detroit, who was also the conference co-chairman.

Transportation was provided for a tour of the Dearborn Engine Plant of the Ford Motor Company.

AVAILABILITY LIST: AUTOMATIC TECHNIQUES CONFERENCE PAPERS

The papers in this list are available in separate copy form until Feb. 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents to members; 50 cents to nonmembers.

Paper No.	Title and Author
58—AUT-1	The Application of Computers to Automotive Design and System Studies, by J. T. Olsztyn
58—AUT-2	Applying the Electrohydraulic Servo Valve to Industry, by Ray Spencer
58—AUT-3	A Survey of the Application of Automatic Devices for Electric-Power Generation, by A. C. Hartranft and F. H. Light
58—AUT-4	Automatic Techniques, Large Computers, and Engineering Calculations, by V. Paschkis
58—AUT-5	Logical Development of the Design for Sequential Control of Chemical Batch Processes, by J. P. Laird
58—AUT-6	Basic Gages and Gaging Considerations for Automatic Machine Control, by J. W. Hopper
58—AUT-7	The Application of the Punch Card to Automatic Weighing of Bulk Materials, by W. M. Young

Notice: Heat Transfer Conference to Be Held at Edgewater Beach Hotel

The Heat Transfer Conference to be presented August 18–21, jointly by The American Society of Mechanical Engineers and the American Institute of Chemical Engineers, will be held at the Edgewater Beach Hotel, Chicago, Ill. Originally the conference was scheduled for Northwestern University. The Exposition, so successful last year at Penn State University, also will be held at the hotel. Sig Kopp is in charge of ASME papers and S. P. Kezios is handling arrangements for ASME. Prof. George N. Brown, at Northwestern University, is in charge of local arrangements.

Conducted for the National Junior Committee

N. J. VIEHMANN[1]

JUNIOR FORUM

Attitudes of Young Engineers

A survey of recent graduates who are Associate Members of ASME

By A. S. Goldstein[2] and N. J. Viehmann[1]

ONE of the functions of "Junior Forum" is to provide a means by which Associate Members can keep abreast of the thinking and the avocational activities of their counterparts throughout ASME. The one group of engineers whose attitudes and opinions are rarely ever heard comprises the graduate engineers who have been in industry two to three years. These individuals who were catered to by industry upon their graduation are now no longer in the limelight. It is this very group that is the object of much of the effort put forth by the National Junior Committee, as it attempts to further the professional interests of young engineers.

The attitudes of these young men, who have just undergone the transition from campus life to the business of building a good foundation for a professional career in industry, are important to themselves, to those in industry who are devoted to improving the quality of the on-the-job training of engineers, and to those who are interested in understanding how the professional society can best serve its novitiates.

The present survey has sought to determine attitudes toward industry and toward the professional society. Does the young engineer believe that industry is doing a good job of handling the transition from engineering college to industry? Do young engineers feel that their training is adequate? Having completed orientation and training, does the young engineer believe that he is being given the work atmosphere, the incentives, and the responsibility conducive to his development as a professional man? Do employers encourage participation in the professional society? Is the young engineer interested in participating in the society's activities? To what does he attribute his lack of participation?

One hundred questionnaires were sent to Associate Members throughout the

Table 1 Factors which influenced 53 young engineers (classes of 1955 and 1956) in the selection of their jobs

	Factor	Weight
1	Type of Work	77
2	Location	60
3	Salary	38
4	Opportunity for Advancement	32
5	Type of Company	31
6	Security	24
7	People Worked With	11
8	Opportunity for Graduate Study	11

Table 2 Factors which 50 young engineers would consider when seeking their next job

	Factor	Weight
1	Type of Work	66
2	Opportunity for Advancement	41
3	Salary	38
4	Location	31
5	Job Status	21
6	Dynamic Growth Company	19
7	Security	14
8	Job Responsibility	10
9	Opportunity for Graduate Study	4
10	People Worked With	4

Survey—Attitudes of Young Engineers

		Circle One	
1	Do you feel that the type of work you are doing now is in line with your capabilities?	Yes	No
2	Was the transition from college to industry handled well by your employer? In what ways?	Yes	No
3	Did you undergo a formal training program?	Yes	No
4	Was the training program adequate? In what ways?	Yes	No
5	Are you being treated as an "engineer"?	Yes	No
6	Do you feel that there is room for advancement in your present position?	Yes	No
7	Is your salary adequate for the type of work you are doing?	Yes	No
8	What were the factors that made you decide upon your present job? (List in order of importance)		
9	What factors do you feel are important in considering a new job now?		
10	Are you encouraged by your employer to continue your education?	Yes	No
11	Are you encouraged by your employer to participate in professional activities?	Yes	No
12	Do you think engineers should be organized as a profession?	Yes	No
13	Do you participate actively in professional activities? In what ways?	Yes	No
14	Would you like to participate actively in professional activities?	Yes	No
15	Would you like to learn more about ASME?	Yes	No
16	What is your field of work?		
17	What is the size of your company?		

<500; 500–1000; >1000

Comments—Use additional sheet.

[1] Product Planning Engineer, Western Electric Company, North Andover, Mass. Assoc. Mem. ASME.

[2] Publications Engineer, Sperry Gyroscope Company, Division of Sperry Rand Corporation, Great Neck, N. Y. Assoc. Mem. ASME.

country who were graduated in 1955 and 1956. More than 50 per cent who were queried replied.

The questionnaire is reproduced elsewhere in this article. If you feel inclined to fill it out and submit it to the Forum, we would be pleased to increase our sample size and to review your opinions.

The large percentage of respondents and the comments submitted with the questionniares indicate a genuine interest on the part of young engineers in their own professional development.

In general, the attitude of the young engineer toward his industrial orientation and training is favorable. Forty per cent of the respondents underwent a formal training program. Relatively few are dissatisfied with job content or status. Of all the respondents only one was active in ASME Section activities, although 80 per cent said they would like to become active in the Society. Thirty per cent participate only to the extent of attending some meetings. Distance to meetings and lack of time due to occupation with graduate studies were the only reasons given for inability to attend meetings or participate actively.

The detailed results are presented in the accompanying graphs. Three fourths of the respondents recognize the need for a functional body that can represent the entire engineering profession. This was brought out in comments made under question 12. These indicated a belief that the profession requires an organization along the lines, perhaps, of the AMA. However, the use of the word "organize" in the question brought forth vehement comments from some 20 per cent of the respondents rejecting the idea of "engineers' unions."

The affirmative replies to questions 14 and 15 indicate that there is a fertile field in which to stimulate greater participation in professional activities on the part of the young engineer.

Note: No attempt of interpretation is made here since the bar graphs are presented solely as a matter of interest. For instance, Fig. 3*c* might be interpreted that young engineers of a more complacent nature enter employment with the larger companies; or it might be interpreted that small companies compensate young engineers inadequately. The number of respondents were as follows: large companies (greater than 1000 employees), 46; small companies (less than 1000 employees), 6.

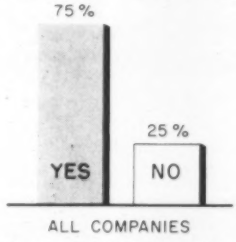
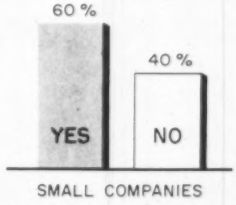


Fig. 1 Was transition from college to industry handled well?



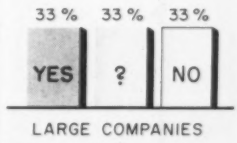
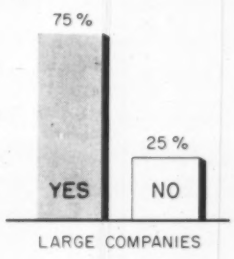
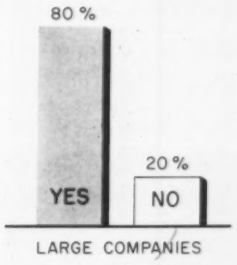


Fig. 2 Was your initial training adequate?

See Note at end of article about interpretation of these graphs





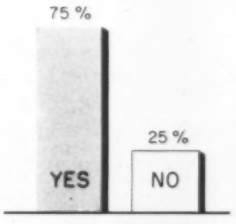


Fig. 3*a* Are your responsibilities in line with your capabilities?

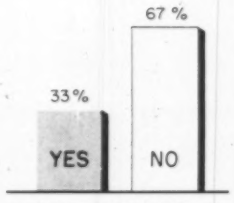


Fig. 3*b* Are you being treated as a professional engineer?

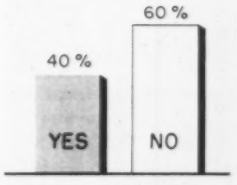


Fig. 3*c* Is your compensation in line with what you feel you are worth?

Fig. 3 Having completed orientation and training, does the young engineer feel he is being given the work atmosphere, the responsibilities, and the incentive conducive to his development as a professional man?

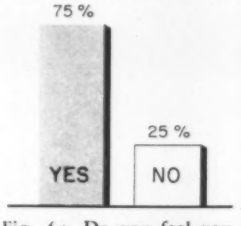


Fig. 4*a* Do you feel you have room for advancement in the job you hold presently?

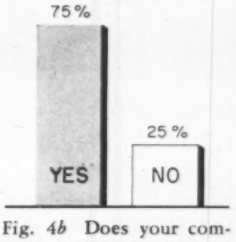


Fig. 4*b* Does your company encourage you to continue with advanced education?

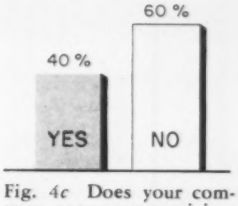


Fig. 4*c* Does your company encourage participation in professional activities?

Fig. 4 Is professional advancement encouraged by industry?

Chairman's Corner

THE National Junior Committee is sponsoring a panel discussion entitled, "Who Controls Your Future?" at the ASME Semi-Annual Meeting in Detroit. Examples of the topics to be discussed are: Creative Thinking, Self Evaluation, and Professional Registration. This meeting is scheduled for 2:30 p.m., June 16.

We also wish to invite those interested to attend the NJC business meeting, tentatively scheduled for 9:00 a.m., June 16. Please consult your program.

William V. Chambers, *chairman*
National Junior Committee,
General Electric Company,
Evendale 15, Ohio

23rd National Power Show to Be Held December 1-5 in New York City

THE 23rd National Exposition of Power and Mechanical Engineering will be held in New York City, December 1 to 5, under the auspices of The American Society of Mechanical Engineers, in conjunction with its 78th Annual Meeting. The display will occupy the first and second floors of the New York Coliseum with exhibits of power-generating and distribution equipment, as well as of applications of power in manufacturing and service industries.

Of special interest will be newly designed equipment reflecting the evolution in structural materials in the two-year interval since the last New York Power Show.

This trend in engineering has improved the blend of metallic and nonmetallic substances in engineering design, resulting in greater capacity and lowered manufacturing costs.

The widening application of atomic energy to civilian uses will be demonstrated in the Atomic Section, which will again be an important feature of the Exposition. Of newsworthy importance will be the concurrent technical sessions of the ASME Annual Meeting, especially those of the Nuclear Engineering Division.

As heretofore, the Exposition will be under the management of the International Exposition Company of New York. E. K. Stevens, president, is the manager of the Exposition.

ASME CODES AND STANDARDS WORKSHOP

Drafting Practice for Plastics Approved by Sponsors

By H. E. Minneman,
Chairman Y14 Subc. 11

Y14 SECTION 11, Drafting Practice for Plastics, has been approved by the American Society for Engineering Education and The American Society of Mechanical Engineers, sponsors of Y14. The Proposed American Standard has been submitted to the American Standards Association for approval as American Standard. Approval is expected shortly, after which copies will be available.

Section 11, Plastics, should be an aid to designers and draftsmen in the delineation of drawings of plastic parts because it contains the recommended practices of various fabricators. Numerous illustrations have been used in conjunction with the design and drawing hints of those details of molded and laminated parts and assemblies which are normally expected to be incorporated in a product designed by drafting personnel. A brief description of materials and forming processes has been included since their consideration is also required in any design.

Mounting Dimensions of Machine-Tool Pumps Now Available

A REVISION of American Standard Mounting Dimensions of Lubricating and Coolant Pumps for Machine Tools has been approved as B5.28–1958 and is now available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

The principal revision was to bring the standard up to date with new NEMA motor-frame data. Foot-mounted, bracket-mounted, and motor-mounted lubricating and coolant pumps are covered.

R. F. Miller Appointed to Boiler and Pressure Vessel Committee

THE appointment of Richard F. Miller as a member of the Boiler and Pressure Vessel Code Main Committee was announced on April 4, 1958, by James W. Landis, President of the Society.

R. F. Miller

Mr. Miller is assistant to the vice-president, research and technology department, of the United States Steel Corporation. He has specialized in research development and testing of alloy steels for elevated temperature applications and is presently serving on the Subcommittee on Stress Allowances for Ferrous Material, Special Committee on ISO/TC-11 and Special Committee on Brittle Fractures.

He is a registered engineer in the State of Pennsylvania, holds two U. S. Patents, and is the author of many technical publications. In addition to his membership in the ASME, Mr. Miller's other affiliations include the AIME, ASM, ASTM, and British Iron and Steel Institute, London.

Plow Bolts Revision Published

A 1958 revision to American Standard Plowbolts, B18.9–1958, has been published by the Society and is now available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Included are Nos. 3 (Regular and Repair), 7 (Regular and Repair), 4 (Repair), and 6 (Repair), with an Appendix covering No. 4 (Regular) and 6 (Regular) for information.

Passenger Conveyers to Be Added to Elevator Safety Code

A GENERAL conference on passenger conveyers (Moving Sidewalks) was called March 4 by ASA at the request of the Society, to determine whether a project should be established on passenger conveyers, and if so, whether under an existing sectional committee or under a new one.

The conference voted unanimously that work should be started, and that it

should be assigned to Sectional Committee A17, Safety Code for Elevators, Escalators, and Dumbwaiters. Sectional Committee B20, Safety Code for Conveyers, had originally drafted provisions covering passenger conveyers in a proposed revision of B20.1–1947.

Additional organizations have been invited to name representatives on Sectional Committee A17, and the scope of that committee has been enlarged to cover the passenger conveyers. Appointment of a subcommittee to prepare a draft code is expected shortly.

Malleable Iron Screwed Fittings Standards Reaffirmed

AMERICAN Standard Malleable Iron Screwed Fittings, 150 Lb. (B16.3–1951), and American Standard Malleable Iron Screwed Fittings, 300 Lb. (B16.19–1951), have been reaffirmed without change.

Correction to Case 30

Code for Pressure Piping Case 30, published in the April, 1958, MECHANICAL ENGINEERING: in Tables 2 and 3, the formula for K Monel should read "66 Ni-29 Cu, Al," instead of "66 Ni-29 Cr, Al."

ASME Representatives Appointed to ASA Groups

HARRY E. LUNDBERG, Mem. ASME, has been appointed one of the Society's representatives on the ASA Chemical Industry Advisory Board, replacing F. H. Conover, Mem. ASME.

Samuel Weckstein, Mem. ASME, has been appointed Society representative on Sectional Committee B54, Identification System for Anti-Friction Bearings. The committee is sponsored by the Anti-Friction Bearing Manufacturers Association.

W. A. Chittenden, Mem. ASME, has been appointed alternate Society representative on Sectional Committee N6, Reactor Safety Standards, sponsored by the Society.

Adoption of Safety Code for Industrial Trucks by States

IN connection with a revision of Safety Code for Industrial Power Trucks (B56.1–1955) now being developed by the committee, a survey was made of the 48 states, asking what safety rules they required for industrial power trucks, which include fork-lift trucks, straddle trucks, and powered hand trucks.

Three states did not reply, and 22 advised they have no rules for this equipment. Ten replied that they used the B56.1 Safety Code, one replied that they were guided by it, and 12 had their own codes.

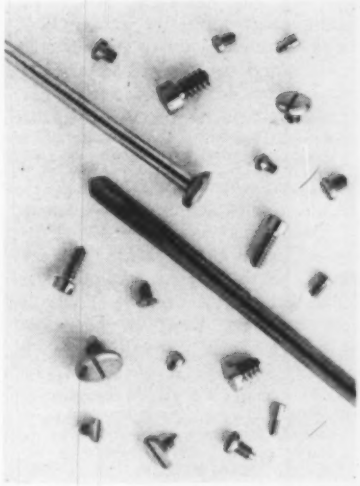
ASME-Sponsored Committees Send Delegates to ISO Meetings

DELEGATES to ISO technical committee meetings in June, 1958, have been nominated by three sectional committees under Society administrative sponsorship.

ISO/TC-1, Screw Threads, is meeting to consider an American-Canadian proposal for an inch system of screw threads, essentially the Unified system now standard in America, Britain, and Canada, as a complement to a metric thread system. Draft ISO Recommendation 84, covering threads with major diameter of 0.01 to 0.197 in., will be discussed and voted upon. This is comparable to the Proposed American Standard Miniature Screw Threads (0.01 to 0.05 in.), shown in the photograph. The meeting is in Harrogate, England, in June.

F. P. Brown, National Bureau of Standards, has attended the meeting of ISO/TC-29, Small Tools, in Berlin, on behalf of Sectional Committee B5, and A. William Meyer, Mem. ASME, will attend the meeting of TC-39 in Harrogate, England, in June.

Four members of Sectional Committee N6, Reactor Safety Standards, were nominated as part of the American delegation to ISO/TC-85, on Nuclear Energy. They are H. A. Wagner, Mem. ASME; Dr. Miles Leverett; Bruce Prentice, Mem. ASME; and Dr. James Terrill.



Miniature Screws: at *top*, common pin; *below*, needle

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the rooms of the Society, New York, N. Y., on April 4, 1958. There were present: J. N. Landis, chairman; E. W. Allardt, C. E. Crede, L. N. Rowley, and G. B. Warren, of the Executive Committee; E. G. Bailey and H. V. Coes, past-presidents; H. S. Aurand and W. H. Byrne, vice-presidents; Joseph Pope and V. Weaver Smith, directors; E. J. Kates, treasurer; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; D. C. A. Bosworth, W. E. Reaser, S. A. Tucker, and J. D. Wilding, assistant secretaries; J. J. Jaklitsch, Jr., editor, and Ernest Hartford, consultant.

Professional Divisions. Reorganization was authorized of the Professional Divisions Committee into a Professional Divisions Executive Committee (of five members) to supervise the activities of the Professional Divisions and Groups of the Society, and a Professional Divisions Planning Committee to consist of the members of the Professional Divisions Executive Committee and a member appointed by each Professional Division to organize, foster, review, and co-ordinate the activities of the Professional Divisions and Groups. The chairman of the Professional Divisions Executive Committee will serve as chairman of the Planning Committee.

National Junior Committee. On recommendation of the National Junior Committee, approval was voted of the appointment of Junior (Associate Member) Representatives on Regional Student Section Committees and Membership Development Committees.

Transactions Quarterlies. On recommendation of the Publications Committee, approval was voted of a Transactions "packaging plan" which will divide the current eight monthly issues of Transactions into three "quarterlies" to be known as the *Journal of Basic Engineering*, *Journal of Power Technology*, and *Journal of Industry Technology* (with the current *Journal of Applied Mechanics* as the

fourth quarterly), effective January, 1959. The titles for new journals are tentative. Authorization was also voted on subscription rates for each quarterly. (See pages 128–129 of this issue for further details.—Editor.)

Certificates of Award. Certificates of Award were voted to the following retiring Section chairmen: Carl F. Simon, Jr., Erie; Earl Hicks, Mid-Continent; Herbert Jesperson, Nebraska; Allen F. Rhodes, South Texas; Gordon E. DeHond, Waterbury; and Roy E. Rayle, Western Massachusetts; to the following past-chairmen of Sections: R. B. Kinzbach, South Texas, 1953–1954; and Hans Hogeman, Western Massachusetts, 1955–1956; and to Brian P. Emerson, for "long and faithful service as secretary to the Oil and Gas Power Division." The Executive Committee also noted that the Board on Codes and Standards had approved presentation of the award established "for persons who have been outstanding in the development of Codes and Standards under ASME sponsorship," to Frank O. Hoagland.

ISO and ABC Meetings. Frank Philippbar, member ASME Secretary's staff, was authorized to attend a meeting June 12–21, 1958, of the International Standards Association Committee 1 and an informal American, British, and Canadian Meeting, June 22–24, 1958, at Harrogate, England, to serve as a recorder for the American Delegation.

Appointments. The following appointments were noted or authorized:

Special Council Committee to Review Engineers Joint Council: E. G. Bailey, chairman; E. J. Kates, V. Weaver Smith, and Joseph Pope.

Special Council Committee on Relationship Between ASME and EIC: A. G. Christie, to replace J. W. Barker who resigned.

Special Council Committee on Group Disability Insurance Plan: Ralph L. Goetzenberger, to act as trustee for ASME.

Annual Meeting. American Academy of Political and Social Sciences, Philadelphia, Pa., April 11–12, 1958; W. E. Belcher, Jr., and Justin J. McCarthy.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

NEW YORK	CHICAGO	DETROIT	SAN FRANCISCO
8 West 40 St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Consultant, Professor, Research, DS Eng.; 36; 14 years mechanical engineering and electrical engineering. Specialist in vibration and noise control. Specialized experience in refrigeration and air conditioning. Excellent record of handling men. Public lecturing and teaching engineering subjects. Prefers East, Midwest, or West. Me-574.

Research and Development of Industrial-Management Engineering, BME; 30; design engineering, 1¼ years; training program in development, technical service, applications, product engineering, and process engineering, 1½ years; concurrent part-time technical translations from Russian and German, 2¾ years. Prefers Eastern U. S. or Foreign. Me-575.

Mechanical Engineer, BS (ME); 25; four years' experience in the development, design, and evaluation of chemical processes. Interests in process engineering, sales to process industry and engineering planning. Has credits toward master's degree in Industrial Administration and has completed a concentrated course in methods engineering. Prefers Pittsburgh, Pa., and vicinity. Me-576.

Plant Engineering, BME; 38; nine-methods design engineer in plant engineering department. Design building installations of a mechanical nature; conduct field investigations; prepare drawings, specifications, estimates; analyze bids and follow contracts for proper installation. Prefers Midwest. Me-577-9674-Detroit.

Mechanical Engineer, BSME; 23; 1½ year designing and testing universal joints. Responsible for projects from initial design through final tests. Prefers Detroit, Mich., area. Me-578-9679-Detroit.

Utility, Operations, BSME; 34; PE; experience in steam-electric power stations, design, operation, and erection; experience in operation and maintenance of boilers, turbines, and station auxiliaries; experience in design and operation of heavy industrial power and industrial telephone systems. Location immaterial. Me-579-883-Chicago.

Research and Development of Mechanical Equipment, BS; 29; 1 year test of gas-turbine engines including responsibility for set-up, instrumentation, data reduction, and evaluation. Present location: Michigan. Me-580-9684-Detroit.

Sales Engineer, BS in Mining Engineering; 36; 15 years sales of engineering services and industrial equipment including pressure vessels, oil field refinery, special equipment. Also sold government agencies. Prefers New York City. Me-581.

Senior Project Engineer, BSE and MME; 35; turbomachinery, pumps, missile ground support equipment, air conditioning, rocket, turbojet and ramjet engines, aerothermodynamics, propulsion systems, 17 years' experience. Location immaterial. Me-582.

Plant Engineer, BME; 34; equipment design, plant layout, development, testing, procurement, supervision of installation, maintenance of machinery, and mechanical equipment, repair, alteration, upkeep of buildings, other structures, and grounds. Anywhere in U. S. Me-583.

Sales Manager or Resident Engineer, BS(ME), EE; 32; nine years' experience in Mexico in sales, design, and installation of mechanical and electrical apparatus. Prefers Mexico City. Me-584.

Vice-President or General Manager, BS (ME), BS (EE); 45; over 20 years in heavy industry, experience in all phases of management, especially in engineering, sales, and operations. Location immaterial. Me-585.

Mechanical-Handling Engineer, Dipl. Ing.; 53; 12 years' experience in mechanical-handling industry as design and project engineer. Lately, construction engineer in large steel work in charge of new material-handling plant construction. Languages: French, German. Prefers Detroit, Mich., New York City, N. J., or overseas. Me-586-9705-Detroit.

Chief Engineer, or equivalent, BSME; 37; 17 years in design, development, and manufacture of products, tools, and special machinery. Employed in electrical connectors design and manufacturing; responsibilities include engineering personnel, design, methods, and all technical liaison. Prefers East, South, preferably Fla. Me-587.

Project Engineer, BSME, MSIE; 31; eight years' experience in management of major projects from design to construction and installation of plant equipment. Has worked with research to develop new equipment to production state. Desires position in plant engineering or maintenance. Prefers Central or northern N. J. Me-588.

Mechanical Engineer, BME, MS, PE; 32; nine years' experience in packaged air conditioning and other heat-transfer equipment design, production, and product-service management. Fluent German. Demonstrated broad managerial ability. Location optional. Me-589.

Factory and/or Production Manager, ME; 40; extensive experience administration and production management, 13 years' experience needle trades (apparel) and light fabrication: piece rates, labor negotiations, engineering economics, cost reduction, multiplant management. Has executive abilities. Prefers Eastern U.S. or Fla. Me-590.

Chief Engineer, MS; 34; ten years' experience special machinery for: automatic assembly, metering and mixing, painting, and striping. R&D: electromechanical equipment, training devices. Product design and development: gear head motors. Held chief engineer position, two years. Prefers Northeast. Me-591.

Design Engineer, BSME; 30; five and one half years' total experience. Design of mechanisms and electromechanical devices. Familiar with manufacturing and quality-control proce-

[1] All men listed hold some form of ASME membership.

dures. Experienced in defense products. Prefers Midwest or South. Me-592.

Technical Executive, MSME; 23 years' experience, ten as chief engineer, assistant director of engineering, and high staff levels. Ability to conceive and exploit research and development activity for a high market performance product. Skilled in all aspects of personnel development and staffing and new or current product development or improvement. Covers power-plant components, appliances, government products, light to heavy machinery, etc. Registered. Me-593.

Chief Manufacturing Engineer, ME; 43; good organizer, cost-conscious, knows supervision, methods, costs, machine design, tool design for mass-produced metal products. Unusually complete knowledge metalworking processes and equipment. Anywhere in U.S. Me-594.

Research and Development Engineer, BSME; 36; five years' experience in development and testing of automotive gas-turbine components and diesel engines. Prefers Detroit, Mich., area. Me-595-9723-Detroit.

Chief Tool Engineer; 51; development and design, project, research, and supervisory, 30 years, 18 of which were in engineering supervision, 12 years practical tool, die, and instrument maker including formal apprenticeship. Manufacturing and engineering experience in the automotive, aircraft, and instrument industries. Competent to reduce manufacturing costs. Prefers Midwest or New York area. Me-596-886-Chicago.

Positions Available

Assistant or Associate Professors, MS or PhD, for undergraduate and graduate instruction. (c) Mechanicals, background in thermodynamics and fluid mechanics. Twelve-month appointments. Ohio. W-4753.

Assistant Director, Schools of Mechanical Engineering, college graduate or equivalent in mechanical engineering, at least two years' actual work experience in the field of mechanical engineering. Writing or teaching experience desired. Must learn the direction and preparation of instructional materials and instructional services which would include writing and editing instruction texts and examinations, etc. $5660–$7547. East. W-5221. Reopened.

Teaching Personnel for Department of Mechanical Engineering, ECPD approved college, preferably under 35, master's degree in either mechanical or aeronautical engineering, preferably both teaching and professional experience in mechanical engineering. $4800–$8400, nine months' teaching. Salary and rank commensurate with educational and professional experience. Gulf Coast. W-6009.

Development and Methods Engineer, 30–45, ME degree preferred, but not a must; creative ability; and a background of production tooling and machine development in cold-headed fastener field. Will analyze inquiries for "specials" to determine if and how they can be made, design special tools required for new items, develop new methods and machinery for producing present product line, investigate new product possibilities, etc. Salary open; fringe benefits. Long Island, N. Y. W-6014.

Plant Engineer, mechanical or civil-engineering degree, 26–35, three to eight years' experience preferably in materials-handling and equipment-layout work, for designing and drawing of equipment and small steel structures in food-processing plant. $8000. Md. W-6029.

Supervisor, Standards Department, 30–45, IE or ME graduate, with experience in supervising a standard department and a knowledge of the metal-fabricating industry, to take charge of standards department and supervise daily operations of incentive systems in plant, installation of standard data program, work on cost-reduction programs and closely with product-processing groups, and will make surveys as to high labor-cost areas. Approximately $9000. Pa. W-6031.

Senior Industrial Engineer, 40–45, IE graduate, at least ten years' supervisory staff and line experience covering budgets, costs, estimates, production, and plant layout in food processing and packaging. $15,000. New York Metropolitan Area. W-6040.

Sales Personnel. *(a)* General sales manager, graduate mechanical or equivalent, 35–45, strong in administrative ability. Must have successfully handled all facets of a complete industrial-sales organization. Should be presently assistant general sales manager or general sales manager of company producing industrial blowers, rotary gas pumps, rotary gas meters, and/or rotating equipment for the positive movement of air, gas, or steam turbines, large industrial com-

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE | NATURE OF WORK DONE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) | Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g. Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS | City | Zone | State

☐

PRIOR HOME ADDRESS | City | Zone | State

* CHECK "FOR MAIL" ADDRESS

I subscribe to

Address changes effective when received prior to:

☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ U—Maintenance and Plant Engineering
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	
	☐ R—Railroad	

pressors, etc. $20,000–$30,000. (*b*) Field sales engineer, engineering degree or equivalent, 28–40, three to four years' industrial-selling experience along equipment line sales. Must be able to make necessary technical computations to satisfy customer demands and insure proper application of equipment. Engineering calculations necessary to select the machine, driver, and accessories. Four to six months' training and four to six months in field prior to account assignment. $6500–$8500. Midwest. W-6044.

Industrial Engineer, graduate of a recognized school of industrial or management engineering, two or maximum of three years' experience in time-study and methods work. This experience in maintenance-type activity would be most desirable. Plant layout, process analysis, etc., desirable. $7200. East Coast. W-6051.

Sales Engineer, 25–35, BSME, three to five years in design and development of electromechanical instruments using precision ball bearings or three to five years as a sales engineer handling precision or electromechanical instruments. Some travel necessary. Salary and commission. Headquarters, Long Island, N. Y. W-6052.

Sales Personnel. (*a*) Manager, steam-turbine sales department, several years' experience in the sale of steam-turbine generators and mechanical-drive steam turbines. Will be responsible for the sale and promotion of these products. Around $10,000, depending upon qualifications and experience. (*b*) Assistant manager, export sales department, who has had experience in handling the sale and application of steam-turbine generators, mechanical-drive steam turbines, or products closely allied involving centrifugal pumps, compressors, steam turbines, etc. Should have experience in handling export negotiations, primarily involving Central and South American countries. $7500–$10,000. Headquarters, East. W-6060.

Secretary, for a standards committee of a trade association, 30–35, technical background and some experience in standardization work, either in a private company or with some organization. Must be able to write clearly, correctly, and concisely. Some trade-association experience helpful. To start, $7500. New York. N. Y. W-6064.

Production Superintendent, degree not required. Must have prior experience as superintendent or assistant superintendent of foundry operation producing aluminum castings. Must know aluminum die-casting production techniques from grooming of die to control of quality and costs. Qualified to expedite production of 2–10-lb die castings. Company may negotiate fee. $10,000–$11,500. Midwest. W-6070.

Design Engineer, 35–55, on plate fabrication, vessel inner and outer shell, pressure and vacuum; plate up to $1/2$ in. stainless steel or aluminum. Will develop standard designs, costs savings, ease of manufacture. Must have tank-shop fabricating experience. $8000–$12,000. Company will pay moving expenses and placement fee. Mass. W-6080.

Chief Engineer, wide engineering background, thorough knowledge of practical engineering design, and ability to direct preparation of engineering drawings to produce maximum results with minimum cost. Position is with a consulting firm which designs special equipment and gives general engineering consulting service. Salary open. Excellent opportunity. South. W-6085.

Co-ordinator, graduate mechanical engineer, ten or more years' experience. Must have general knowledge of heating and electrical work, design, and plumbing on industrial and commercial buildings. Company operates throughout eastern U. S. Salary open. Company pays placement fee. Central N. J. W-6088.

Research and Development Manager, graduate mechanical, 35–45, for fabricated industrial products of metals and hard plastics for use by industry. A minimum of seven years' experience, one or two years' experience on production of industrial products desirable. Salary open. East. W-6089.

Engineers. (*a*) Engineering department manager, graduate mechanical or chemical engineer, eight to 12 years' experience in plant engineering in a chemical plant. Previous supervisory experience required. Supplemental experience in an engineering company engaged in chemical-plant design and construction desirable. (*b*) Process engineers; five inexperienced and 12 experienced. Company pays placement fees. Pa. W-6092.

Sales Engineer, graduate mechanical or electrical, five or more years' experience selling to industrial accounts for company manufacturing plastic extrusions for industry. Salary open. Travel four to five days a week, home week-ends. Territory, New England and N. Y. State. W-6098.

Powerhouse Superintendent, mechanical graduate, maintenance and operating experience in steam-turbine power plant and process industry. License desirable. Must speak Spanish. $8000. Mexico. F-6101.

Administrative Assistant, under 35, technical degree and knowledge of plastics industry, to work primarily in advertising sales, meetings operation, and public relations. Direct experience in these or related fields required. Position is with an engineering society. Conn. W-6103.

Engineering Adviser, 50–60, degree, to survey all eligible proposals as to feasibility of financial assistance. Professional training in business administration, industrial production, or general engineering practice at management levels required, preferably in a variety of industries. Knowledge of several languages desirable. $18,000–$25,000. East. W-6113.

Engineers. (*a*) Project engineer, BSME, to analyze facility requirements for new or improved product, or manufacturing operation for fabrication or assembly of heavy machinery or structures, including requirements for increased capacity and rearrangement or rebuilding of existing facilities, etc. A minimum of two years' experience on afore-mentioned requirements. $9000. (*b*) Manufacturing engineer, BSME, to analyze present methods, equipment, layout, and tooling for handling, fabrication, and assembly of materials for manufacture of heavy machinery and structures; select improved manufacturing processes, methods, etc. Minimum of three years' experience in the aforementioned requirements. Salary open. Pa. W-6120.

Scheduling Engineer or Co-ordinator, 35–45, graduate mechanical, chemical or civil, for the engineering and construction division of a large chemical plant manufacturer. Experience must be in oil refinery or chemical plant. $8000–$10,000. New York, N. Y. W-6124.

Designer, mechanical graduate, ten years' experience with pressure-vessel fabricator. Must be familiar with ASME code and alloys. $10,000–$12,000, plus bonus. Upstate N. Y. W-6138.

Sales Engineers. (*a*) Graduate engineer, about five years' experience in air-conditioning field with special emphasis on large engineered air-conditioning systems; considerable experience with high-pressure induction systems required. Will contact consulting engineers to obtain specifications and approval of heating, ventilating, and air-conditioning equipment. Must be top flight air-conditioning engineer and salesman. $10,000, plus sales expenses. (*b*) Sales engineer, graduate, business administration degree desirable, to contact owners, architects, general contractors, banks, etc., to promote sale of heating, ventilating, and air-conditioning equipment. Must be completely familiar with air-conditioning systems as they affect building design, construction, and cost. Must be able to prepare accurate estimates of owning and operating costs, etc. Must be top flight salesman. $10,000, plus sales expenses. Both positions, N. Y. area. W-6140.

Engineers. (*a*) Plant engineers, mechanical or chemical, BS degree or better, 30–35 preferable, minimum of five years' experience in this field, preferably in the chemical or food industry. Experience should include design, maintenance, construction, industrial building, and services. Contact with outside contractors important. To $8400. (*b*) Plant engineer, chemical or mechanical, BS degree or better, 30–35 preferable, experience in either chemical or allied industry. Must have five years' experience in refrigeration, air conditioning, pilot-plant operation, design, or general plant engineering. To $8400. (*c*) Design engineer, minimum of ten years' experience designing small machines and mechanisms, preferably in the chemical or food industry. Must have a good knowledge of machines, mechanisms, and machine components. To $8400. Company pays all moving expenses and placement fees. Mich. W-6142.

Design Engineer, 30–40, mechanical graduate, at least five years' design and development experience on industrial hydraulic-piston pumps and motors. $8000–$10,000. Upstate N. Y. W-6145.

Teaching Personnel. (*a*) Instructors, BS in mechanical engineering, to teach engineering drawing and descriptive geometry. Opportunity to take postgraduate courses. (*b*) Assistant professor to teach afore-mentioned subjects. Should have master's degree in engineering and some experience in teaching. Positions available September, 1958. South. W-6147.

Assistant Manager, Lubricant Development, 35–40, preferably some experience in marketing, sales, and advertising. Must have some previous experience in selling lubricant additive. $9000–$10,000. New York, N. Y. W-6148.

Assistant Applications Engineer, graduate mechanical or electrical, 22–25, preferably year or two in the precision-instrument or bearings field, or in the design and development of rotating electromechanical or servomechanical equipment. Under direction, will perform highly technical-engineering duties primarily related to the design and application of small high-precision ball bearings. Will assist in computing performance, application, and design data, etc. $5500–$6500. New England. W-6149.

Cost Analyst, Market Research, degree in industrial, mechanical, or civil engineering, 30–38; three to four years in heavy fabricating or manufacturing industry, functioning as cost estimator of operations and materials, machine and structural designer, cost and operation standards; know aluminum fabricating methods, joining, forming, finishing, casting, etc. Will assist market research to assess potential aluminum markets particularly from a cost standpoint. Contact manufacturers to evaluate cost of present materials and fabricating methods being used. Gather and analyze comparative cost information to estimate possible aluminum penetration in potential markets; 35 per cent travel, no car required. Position is with a primary producer of aluminum. $7200–$9600. Employer will pay placement fee. Chicago, Ill. C-6808.

Chief Test Engineer, graduate engineer or physicist, background in thermodynamics, metallurgy, nucleonics, electromechanical controls, and computer applications. At least five years' experience in engineering or scientific laboratory. Will direct an existing group in engineering tests of industrial-package steam generators, and related components, precision temperature control, and a wide range of electromechanical devices in well-equipped plant. $7500–$12,000, depending on qualifications. Employer will pay placement fee. Chicago, Ill. C-6813.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after June 25, 1958, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and •Transfers

Arizona

• HEISLEY, FREDERICK L., Phoenix
KELTNER, ROBERT N., Phoenix

California

BRANDON, KENNETH F., El Segundo
BROWN, WINFRED E., Huntington Park
CRONKHITE, VERN E., San Francisco
EGHOIAN, VAHAN, Sacramento
• FORSYTH, STUART L., Berkeley
JOYCE, CARL E., Pasadena
LOPER, ROGER D., San Francisco
MILES, KENNETH L., San Francisco
MILLER, WILLIAM V., Los Angeles
NIXON, VAUGHN D., San Jose
PIPES, EDWARD J., Santa Clara

Colorado

HARDIN, THOMAS D., Denver
• RUUD, FREDERICK O., Denver
SORENSEN, ROBERT W., Boulder
TALLMAN, KENNETH G., Boulder

Connecticut

DICAMILLO, RAYMOND J., Bridgeport
• SAPEGA, AUGUST E., Hartford

Delaware

DUTTON, HUBERT W., JR., Newark

Florida

GARDNER, ROBERT L., Pensacola

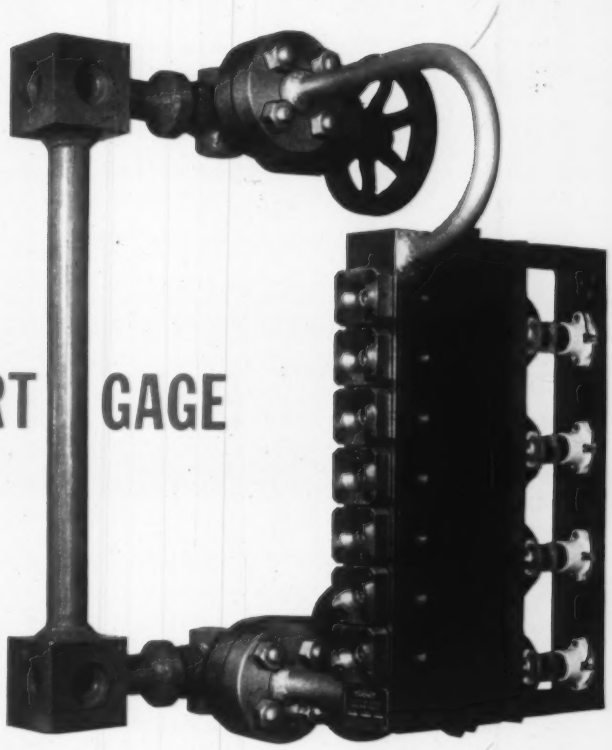
Idaho

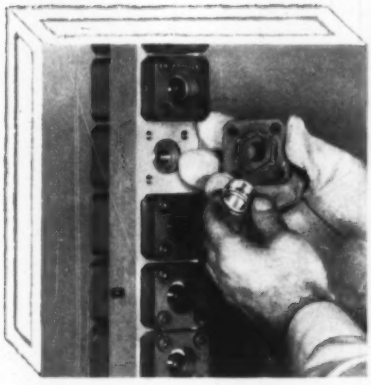
MONTGOMERY, CLAYTON R., JR., Idaho Falls

(*ASME News continued on page 156*)

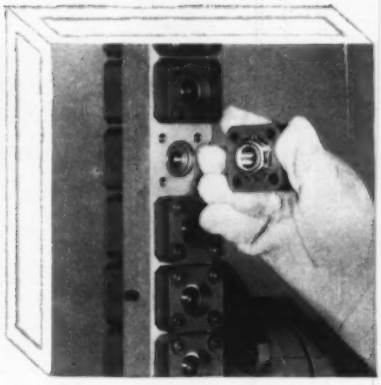
• Transfer to Member or Affiliate.

servicing the new YARWAY COLOR-PORT GAGE is easy as a b c

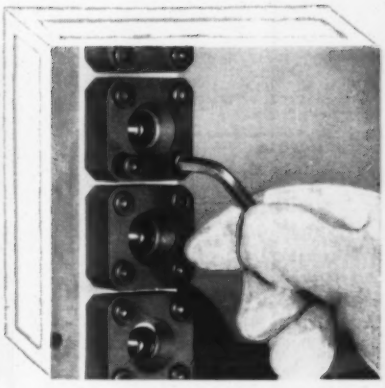




a Remove four Allen cap screws and lift off cover assembly. Replace port assembly (glass-mica-gasket assembly) in cover.



b Re-install complete cover assembly. Sealing gasket automatically seats in gasket groove in body.



c Tighten down four Allen cap screws with standard wrench (no torque wrench required).

New Yarway Color-Port Boiler Water Level Gages (for pressures to 3000 psi.) offer not only this new ease of maintenance but insure brilliant red and green readings of steam and water.

For full details, write for Yarway Bulletin WG-1814.

YARNALL-WARING COMPANY, 108 Mermaid Ave., Philadelphia 18, Pa.
Branch Offices in Principal Cities

GO YARWAY WITH CONFIDENCE

Illinois

CHRISTENSEN, KENNETH K., Lombard
FOSTER, EUGENE A., Chicago
HALBERG, ROBERT W., Des Plaines
JOHNSON, CARL H., Rockford
KRAMER, JOHN F., Meredosia
KUTILEK, JOHN L., Glenview
MAINELLI, MICHAEL R., Chicago
MAURER, RAYMOND H., Chicago
OGLE, CLINTON K., Metropolis
PARTOS, ERNEST J., Chicago
● RATCLIFF, HAROLD B., Peoria
ROBINSON, RONALD R., Morton
ZUCKER, PAUL R., Chicago

Indiana

BARRETT, MAURICE L., JR., Indianapolis
HEISE, ELMER B., Michigan City

Iowa

BOTTACCINI, MANFRED R., Iowa City
SCHRIMPER, VERNON L., Cedar Rapids
● SMITH, RICHARD W., Cedar Falls

Kentucky

MITCHELL, EARL T., Paducah
SEEL, JOHN R., Benton
● VAN DYKE, BURTON, Louisville

Louisiana

DU PONT, LOUIS C., Baton Rouge
THERRELL, FRANK A., JR., Shreveport

Maryland

BAYLES, CHARLES B., Severna Park
● ELLIOTT, DANIEL P., Severna Park
● KEYES, NORMAN C., JR., Baltimore
MATTIX, PAUL R., JR., Silver Spring
● SCHLITZER, HENRY J., Baltimore

Massachusetts

BRANDOLI, RAYMOND A., Agawam
CALLAHAN, FRANCIS J., Concord
● DAVISON, WELLEN G., Springfield
KELL, WILLIAM, JR., Auburndale
LUNNEY, EDWARD J., Wellesley
MAIN, CHARLES T., 2ND, Winchester
● RITTENHOUSE, EARL G., Jamaica Plain
ROGALA, TADEUSZ, Lawrence
● TSCHIRCH, ROBERT E., Swansea

Michigan

CODDINGTON, WILLIAM H., Detroit
FISCHER, KENNETH C., Midland
MCCARTHY, JOSEPH F., Jackson
RAPP, RAYMONT W., Hazel Park
● SMURR, FLOYD W., Jackson
SNYDER, NORMAN F., Flint

Minnesota

TSCHANNEN, ERNEST E., Minneapolis

Missouri

SMITH, JACK P., Kansas City

Montana

● HENDRON, ROBERT H., Helena

Nebraska

EDGINGTON, JOHN H., Omaha

New Jersey

CONLIN, ALAN B., JR., Fanwood
HAMBERG, OTTO, Livingston
● LONGSON, JOSEPH, Waldwick
MAASS, ROBERT H., Linden
MELLOR, GEORGE L., Princeton
VITE, VERNER C., Montclair

New Mexico

MARKS, JAMES H., JR., Albuquerque
RUNYAN, CHARLES E., Albuquerque

New York

BRANNAN, JACK, Richmond Hill
COLLINS, JOHN L., Corning
EISINGER, FRANK, New York
FERRARO, ATTILIO M., Brooklyn
FLOWER, ARTHUR J., Lancaster
FREEMAN, MARVIN LEE, Forest Hills
FRENDBERG, ARTHUR M., New York
FULLER, ROBERT M., New York
● LUSTENADER, EDWARD L., Scotia
MINCK, LAURENCE A., Yonkers
MORRIS, CHARLES, New York
NORDIN, GERHARD, New York
OPINANTE, EUGENE N., Brooklyn
PHILLIPS, REUBEN, Brooklyn
RUBMAN, DANIEL L., New York
SLUSSER, JOHN L., Port Washington
SMITH, GEORGE D., Wellsville
STERN, JESSE, Mount Vernon
TOMLINSON, WALTER J., JR., New York
TRAMPOSCH, HERBERT, Brooklyn
TUTTLE, ALAN H., Andover
WILKINSON, HAROLD E., New York

North Carolina

GRISCOM, HARRY F., JR., Charlotte
REEP, CHARLES L., Charlotte

Ohio

DAY, ROSS W., Columbus
● HEISSERMAN, ROBERT E., Cleveland
● LIPINSKI, CHESTER J., Toledo
MOORE, FRANCIS L., New Philadelphia
● PANKRATZ, GEORGE E., Toledo
POPE, JOHN T., Akron
SCHAEFER, RAYMOND F., Cleveland
WAGNER, WILLIAM S., Navarre

Oklahoma

MCELROY, ARTHUR H., Tulsa
SKIDMORE, HERBERT B., Ponca City

Pennsylvania

ALLEN, JOHN W., Carlisle
BARR, DAVID, Ambridge
BRAND, WILLIAM J., New Kensington
KRISTIANSEN, LARS J., Pittsburgh
LOGAN, JOHN W., JR., Pittsburgh
MERRIN, ROBERT S., Philadelphia
SACK, THOMAS F., Scranton
SNUTTJER, OWEN R., Wilkinsburg
SWARTZWELDER, JOSEPH H., New Kensington
WOODWELL, ROBERT G., Glenolden

Rhode Island

GRISWOLD, DONALD D., Rumford
ONAT, EMIN T., Providence

South Carolina

● CORKER, ROBERT P., Aiken
DIETZ, ROBERT H., Aiken
HORNBECK, DARRELL E., North Augusta
● WILSON, WILLIAM G., North Augusta

Tennessee

HENRY, CARL P., Nashville
MAXWELL, HUGH F., Memphis
TRENT, TOM L., JR., Knoxville
YAO, CHENG, Chattanooga

Texas

CAREY, ROBERT M., Dallas
GLOVER, WALTER, Houston
● GRAFF, WILLIAM J., JR., Dallas
SHERMAN, WILLIAM E., Houston
VANCEY, EARL C., Lake Jackson

Utah

HANSEN, JEROME R., Salt Lake
OWENS, BURTON, Kanab

Vermont

LINDNER, HERBERT E., Northfield

Virginia

● ALEXANDER, BEATINA W. (MRS.), Alexandria
● SCHMIDTKE, RICHARD A., Fairfax

Washington

DARLINGTON, EDWARD G., Spokane
● LEE, HARRY A., Richland

West Virginia

CROUSE, HOUSTON E., Moundsville
DORSEY, MARION U., South Charleston
DUNN, ERNEST G., Charleston
HALL, MAYNARD E., Montgomery
SPANGLER, GEORGE R., Hurricane

Wisconsin

BHARUCHA, FAROKH M., Elm Grove
HARTZ, MARVIN E., Milwaukee
● PIPKORN, RUSSELL H., Milwaukee

Wyoming

● KEETH, ALLAN F., Casper

Foreign

BROWNE, JOHN P., Toronto, Ont., Canada
● COUTRIS, ACHILLES W., Paris, France
GHOSH, SATYA P., Wolverhampton, England
HEYNISZAR, WALDEMAR, Cullercoats, Northumberland, England
LLOYD, JOHN E., Montreal, Que., Canada
LONGTHORNE, WILLIAM, Montreal, Que., Canada
NEILL, ROBERT D., Fredericton, N. B., Canada
● ROTHERMEL, EARL H., Honolulu, Hawaii
SION, NICOLAS N., London, England
● TOBER, ZOLTAN J., Wellington, New Zealand

OBITUARIES

Comfort Avery Adams (1868-1958), professor-emeritus, Harvard University, and consulting engineer, Philadelphia, Pa., died Feb. 21, 1958. Born, Cleveland, Ohio, Nov. 1, 1868. Parents, Comfort A. and Katherine (Peticolas) Adams. Education, SB, Case School of Applied Science, 1890; hon. EE, 1905; hon. DE, 1925; hon. DE, Lehigh University, 1938. Throughout his undergraduate period he was laboratory assistant to the noted physicist, Dr. A. A. Michelson, and participated in the early development of the interferometer. Married Elizabeth C. Parsons, 1894; sons, John and Clayton. Mem. ASME, 1917; Fellow ASME, 1939. Dr. Adams' engineering career in education, writing, and consulting spanned 68 years. In that period he distinguished himself in many areas and was the recipient of numerous awards some of which follow: First recipient of AWS Miller Medal, 1929, for "conspicuous contributions to the welding art"; AIEE awarded him the Lamme Medal in 1940 and the Edison Medal in 1956. He became interested early in the design of electrical machinery and his concentrated study in this field resulted in many important published contributions, particularly in the field of a-c machinery. His contributions to design are well known throughout the civilized world. He was the author of "Dynamo Design Schedules," the a-c machinery section of the standard handbook for electrical engineers, and of two chapters in Andre Blondel's book on "Synchronous Motors and Synchronous Converters." From 1934 to 1948 he served the Society as a member of the main committee of the ASME Boiler and Pressure Vessel Committee and was made honorary member of the committee in 1948. His services to the engineering profession, in general, encompassed a wide range. He organized the American Engineering Standards Committee of which he was the first chairman and which was later expanded into the American Standards Association, now the recognized co-ordinating body in the broad field of standardization. He performed a similar task for the American Welding Society and was its first president in 1919. He was a fellow and, in 1918, president of AIEE. He served on The Engineering Foundation Welding Research Committee and, in 1949, was made honorary chairman. He was one of the prime movers in the organization of the American Engineering Council. A fellow of several other professional and learned societies, national and international, he was also a member of Sigma Xi and Tau Beta Pi. Dr. Adams was president of the John Fritz Medal Award Board and a past-chairman of the Edison Medal Committee. In 1891 he joined the faculty of the Harvard University as instructor in electrical engineering, then assistant professor, and professor. From 1919 to 1920 he was dean of the school. He was retired in 1936 with the title, Abbott and James Lawrence Professor of Engineering and Gordon McKay Professor of Electrical Engineering, emeritus. During World War I he was chairman of the Welding Committee of the Emergency Fleet Corporation; chairman of the Engineering Division of the National Research Council; and, in 1917, President Wilson appointed him a member of the general engineering committee of the advisory commission of the Council of National Defense; he was made chairman later. As an engineering consultant for more than 40 years he was associated with many of the world's leading corporations in the electrical, cotton nitrating, and sugar industries. Also he ranked high as an authority in gas explosions and testified successfully in many legal cases. He was considered an expert in high-frequency induction heating. To each of these fields he brought new techniques and processes as well as designing new apparatus, which were later to receive world-wide acceptance.

James Neal Addoms (1920-1958), assistant director, chemical engineering department, Atlas Powder Co., Wilmington, Del., died Jan. 30, 1958. Born, Brooklyn, N. Y., July 1, 1929. Education, BS, Haverford College, 1942; DS, Massachusetts Institute of Technology, 1948. Mem. ASME, 1952. A heat transfer specialist, Dr. Addoms had been a member of the chemical engineering faculty of the Massachusetts Institute of Technology for three years before joining Atlas Powder Co. He had published several articles in technical journals.

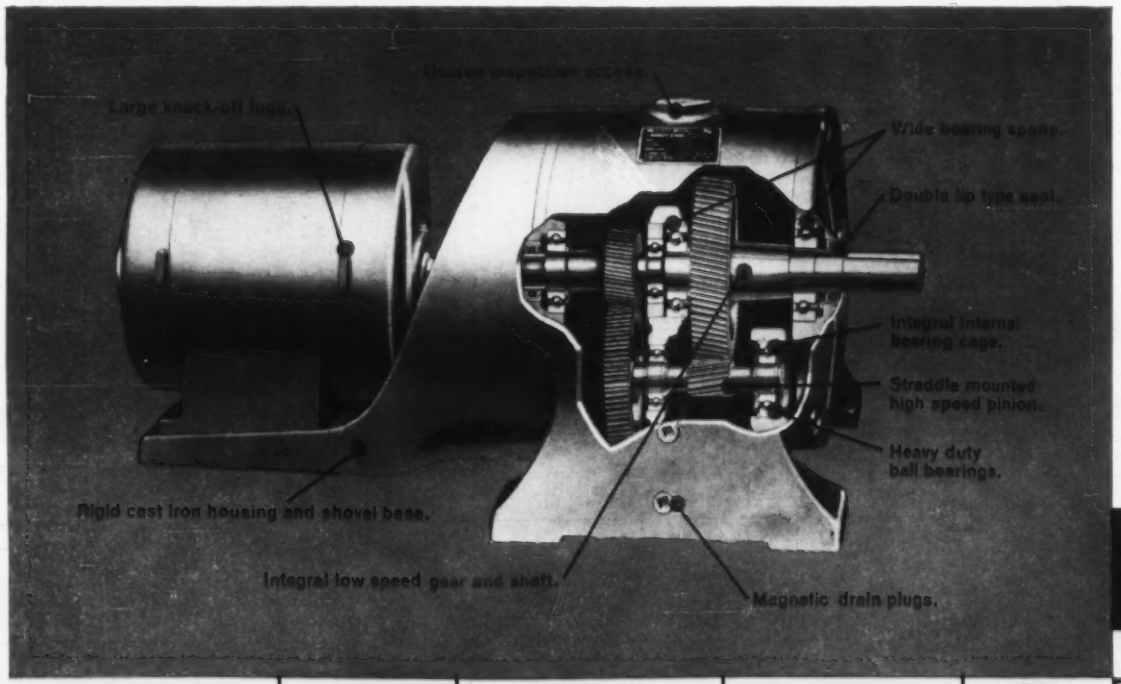
Andrew Anthony Bato (1885-1958?), whose death recently was reported to the Society, had

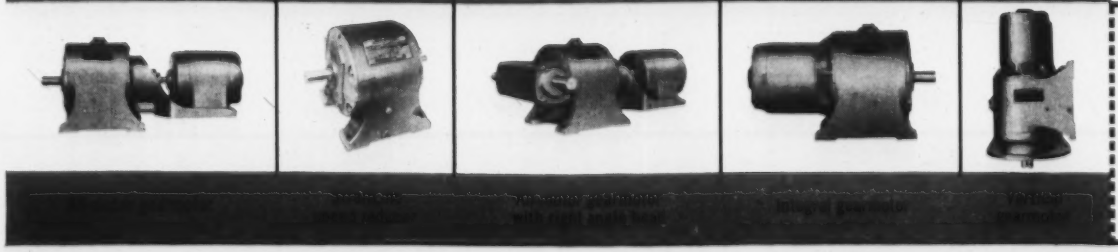
(*ASME News continued on page 158*)

CLIP AND SAVE

MORE USER BENEFITS PER DOLLAR

with Western Gear *STRAITLINE* gearmotors! Check 'em!


Large knock-off legs.
Unique inspection access.
Wide bearing spans.
Double lip type seal.
Integral internal bearing cage.
Straddle mounted high speed pinion.
Heavy duty ball bearings.
Rigid cast iron housing and shovel base.
Integral low speed gear and shaft.
Magnetic drain plugs.



For 25 years, Western Gear has designed and manufactured gearmotors for major electric motor manufacturers. During this quarter century, Western Gear has gained matchless experience in the gearmotors field and has learned exactly what gearmotor users want. Feature-for-feature, Western Gear StraitLine Gearmotors, now manufactured and marketed under Western Gear's own name, offer users the greatest list of benefits in the field. If you buy gearmotors, either as a user or an OEM supplier, the full story of the benefits for you in Western Gear StraitLine Gearmotors is required reading and listening. Get the story from your nearby Western Gear man or distributor. And for a starter, use the coupon in this ad to get our basic bulletin No. 5806-F.

See your Western Gear Man in all principal cities about StraitLine gearmotors.

"The difference is reliability" • Since 1888

5805

WESTERN GEAR *Corporation*

ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, CALIF., SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

Western Gear Corporation, Att.: Glenn Malme
P. O. Box 182 · Lynwood, California
Send me StraitLine Gearmotors Bulletin 5806-F.

name _____

title _____

company _____

address _____

city _____ state _____

been a consulting engineer, South Orange, N. J. Born, Budapest, Hungary, May 1, 1885. Parents, Henry and Adeline (Fellner) Bato. Education, BA, Model Gymnasium, 1902; ME, Budapest Technical University, 1907. Married Mary Ranschburg, 1918; son, Andrew Gabriel Bato. Assoc-Mem. ASME, 1924; Mem. ASME, 1927. Naturalized U. S. citizen, Newark, N. J., 1920. Mr. Bato had published several papers in technical journals and had been editor of the engineering column of *Laundry Age*. He had also taught engineering subjects at Essex County Vocational School. He was a registered professional engineer in the states of New York and New Jersey.

Herbert Albert Cohn (1888–1958), superintendent of construction, Westinghouse Electric Corporation, Pittsburgh, Pa., died Feb. 7, 1958. Born, Pittsburgh, Pa., April 30, 1888. Education, high-school graduate. Mem. ASME, 1949. A registered professional engineer in the State of Pennsylvania, Mr. Cohn had been a specialist in design, construction, and installation of power and process plants.

Thomas Russell Cook (1881–1958), retired, senior engineer, Covedale & Colpitts, New York, N. Y., died Feb. 27, 1958. Born, Oshkosh, Wis., June 9, 1881. Parents, Ossian and Edna (Day) Cook. Education, BS(ME), University of Wisconsin, 1900. Married Florence De Forest, 1913; one daughter, Constance Russell Cook. Mem. ASME, 1911. Mr. Cook held a number of patents related to railroad equipment and storage batteries.

Kenneth S. M. Davidson (1898–1958), for 23 years director, Experimental Towing Tank, Stevens Institute of Technology, Hoboken, N. J., and recently chief scientific adviser at SHAPE died March 19, 1958, in Paris. Born, Buffalo, N. Y., Feb. 9, 1898. Parents, Frank and Minnie S. J. Davidson. Education, BS(ME), Massachusetts Institute of Technology, 1920; DS, Stevens Institute of Technology, 1944. Married Katharine Staples, 1923. Jun. ASME, 1924; Assoc-Mem. ASME, 1931; Mem. ASME, 1935. Dr. Davidson's work on hydrodynamics made possible the use of small towing tanks and models as research instruments. This opened a much broader field of research than was previously possible. He developed a practical method of predicting power of ships from tests of small models under unstable conditions, such as turning, pitching, and rolling. Dr. Davidson greatly expanded the services of the towing tank to include the problems of all types of vessels. During World War II he concentrated on tests of destroyers, motor torpedo boats, and seaplanes. His work in this field earned him the initial Joseph H. Linnard prize of the Society of Naval Architects and Marine Engineers in 1937; that society's first President's Award; and the John Price Wetherill Medal of The Franklin Institute in 1947. In 1955, SNAME again honored him with its Gold Medal. During World War I, he served as a pilot in the air branch of the Army Signal Corps. On leave from Stevens, he had most recently been chief scientific adviser at Supreme Headquarters, Allied Powers in Europe where he conducted studies on the feasibility of applied nuclear energy to existing and new type of seaplanes. In addition to his duties at SHAPE, he was a member of the Underseas Warfare Committee, Panel on Hydrodynamics of Submerged Bodies, National Research Council, and many other groups. He served the Society as a member of the Power Test Codes Committee. Survived by his widow, and a daughter, Ann.

David S. Faulkner (1885–1956), vice-president, The National Supply Co., Torrance, Calif., died Oct. 11, 1956. Born, Grafton, N. Dak., Nov. 16, 1885. Education, BS(ME), Purdue University, 1909. Jun. ASME, 1912; Assoc-Mem. ASME, 1913; Mem. ASME, 1935. Mr. Faulkner had been associated with the Union Tool Co., Torrance Calif., in positions from sales engineer to president from 1914 to 1927. In 1927 that company was absorbed by the National Supply Co. with which he was associated until the time of his death.

Charles E. Gorton (1872–1955), retired chairman, American Uniform Boiler Law Society, and former manager and vice-president ASME, died August, 1955. Born, Albert Lea, Minn., June 14, 1872. Education, Polytechnic Institute of Brooklyn and New York University. Mem. ASME, 1915; Fellow ASME, 1936. Mr. Gorton was manager of the Society in the period 1925 to 1928; and was a vice-president, 1928 to 1930. He was appointed to the Advisory Committee of the ASME Boiler Code Committee in 1912, and later became a member of its executive committee. He was a member also of the Society's Membership Committee. The Administrative Council of the American Uniform Boiler Law Society, of which he was chairman, was instrumental in the adoption of the ASME Boiler Code in many states. Survived by his widow, Florence M. Gorton, Adrian, Mich.

Edward Glennan Grady (1903–1957?), whose death recently was made known to the Society, had been plant engineer, Masonite Corp., Laurel, Miss. Born, Savannah, Ga., Feb. 17, 1903. Education, attended Georgia Institute of Technology. Mem. ASME, 1941. A specialist in steam, electric, and water problems, Mr. Grady was in charge of design, construction, and operation of a 13,000-kw, 400-psig, 750-F steam generating plant for Masonite.

Charles William Hathaway (1896–1958), assistant mechanical superintendent, E. I. du Pont de Nemours & Co., Inc., Belle, W. Va., died Feb. 16, 1958. Born, Springfield, Ohio, Feb. 4, 1896. Education, BS(ME), Case Institute of Technology, 1917. Mem. ASME, 1951. Mr. Hathaway was a past-chairman of the ASME West Virginia Section, was active on many Society committees, and took an active part in local and civic organizations.

Charles Wesley Hubbell (1875–1958), editor-in-chief, International Correspondence Schools, Scranton, Pa., died March 9, 1958. Born, Pittston, Pa., Dec. 26, 1875. Parents, Seth Gardner and Melvina (Williams) Hubbell. Education, ME, Cornell University, 1907. Mem. ASME, 1913. Mr. Hubbell had been with ICS for almost 20 years as writer and editor of such subjects as shipbuilding, marine engineering, management, shop practice, and so on. For a period during World War II, he prepared instruction pamphlets for the U. S. Navy Bureau of Aeronautics.

André L. Jorissen (1913–1958), professor and head of the hydraulics and hydraulic engineering department, Cornell University, Ithaca, N. Y., died Feb. 27, 1958. Born, Liége, Belgium, Jan. 17, 1913. Education, CE, University of Liége, 1935; ME, Massachusetts Institute of Technology, 1937; DE, University of Liege, 1949. Naturalized U. S. citizen, New York, N. Y., 1954. Mem. ASME, 1950. His teaching career began with an assistantship at the University of Liége in 1937. He was an associate in the Belgian National Fund for scientific research from 1943 to 1949. In this period also he was an advanced fellow with the Belgian-American Foundation, and scientific adviser to the Laboratoire Central d' Hydraulique in Paris, France. He then joined the Pennsylvania State College faculty in 1949 as associate professor in civil engineering, leaving it as a full professor to join the Cornell faculty in 1951. He was honored by the University of Liége as Ingénieur des travaux, urbains et coloniaux, and was a Hooker fellow from Cornell for European travel. Professor Jorissen was the author of numerous scientific articles, many of which dealt with measurement standards. He worked on several committees for the standardization of flow measurements including an ASME Special Research Committee on Fluid Meters. Survived by his widow, Lucia A. Jorissen; a daughter, Anne Jorissen; and brother Pierre of Brussels, Belgium. Member Tau Beta Pi and Sigma Xi.

Leo Leonard Lichon (1911–1958), production engineer, The Wickes Boiler Co., Saginaw, Mich., died March 7, 1958. Born, Saginaw, Mich., March 9, 1911. Education, ICS, 1928. Mem. ASME, 1953. Mr. Lichon had been with The Wickes Boiler Co. since 1928.

Felice George Pasotti (1896–1958), plant manager, The Lynch Corp., Anderson, Ind., died March 9, 1958. Born, London, England, July 31, 1896. Education, Regent St. Polytechnic, 1912; attended University of London, 1915 and later did postgraduate work there. Mem. ASME, 1947. In England, Mr. Pasotti had for many years devoted his efforts to glass-bottle-making machinery and in 1933 he came to the U. S. joining Ball Bros. Co., Muncie, Ind., at their invitation. He wrote many scientific papers on the subject of glass machinery and held many patents on the same subject. He was a registered professional engineer in the State of Indiana. Mr. Pasotti was active in the affairs of the Central Indiana Section of ASME.

Thomas Doane Perry (1877–1958), consulting engineer to the woodworking industry, Moorestown, N. J., died March 12, 1958. Born, Boston, Mass., May 27, 1877. Parents, David B. and Helen (Doane) Perry. Education, AB, Doane College, 1897; BS(ME), Massachusetts Institute of Technology, 1900. Married Ethel Goodenough Britton, 1903. Assoc-Mem. ASME, 1917; Mem. ASME, 1925; Fellow ASME, 1947. Mr. Perry had a long and varied career; the largest part of which was devoted to the wood-products industry. He was associated with such companies as Grand Rapids Veneer Works; Bigelow, Kent, Willard & Co.; New Albany Veneer Co., United Plywood Corp.; Jasper Wood Products Co.; and Resinous Products & Chemical Co. Mr. Perry was a member of the original committee which organized the ASME Forest Products Division, now the Wood Industries Division. In the Division's 30-year history, he had contributed vigorous leadership and for seven years served as chairman of its Executive Committee. He had not only contributed directly to the program of the Division by presenting numerous technical papers, but he had long been the mainstay of the program committee in soliciting papers. He was a well-known author of two valuable reference books "Modern Plywood" and "Modern Wood Adhesives." Several patents in the woodworking field were taken out in his name.

George Francis Pettinos (1862–1958), president, George F. Pettinos, Inc., Philadelphia, Pa., died Feb. 21, 1958. Born, San Francisco, Calif., Sept. 20, 1862. Parents, George Francis and Sarah (Porter) Pettinos. Education, Dickinson College, BS(ME) Lehigh University, 1887. Married Frances Palmer Snowhill, 1916. Mem. ASME, 1913. Mr. Pettinos began his career as a laborer in the Bethlehem Iron Works (now Bethlehem Steel Corp.) and rose to chief engineer in which position he was responsible for the design of the first open hearth furnace. In 1892, he organized his own business importing and processing graphite, and later mining industrial sand. The company now produces more than 150 different kinds of sand for foundries, water filtration and sewage disposal plants, glass, and many other industries. Mr. Pettinos was an accomplished musician, worked his way through Lehigh by playing the violin, and for many years played first violin in the Bethlehem Symphony Orchestra. He held a patent for a universal pulverizing machine. He was a member also of The Franklin Institute and one of the charter members of the American Foundrymen's Association. Survived by his widow, Pauline Cope Pettinos; a son, George F., Jr.; and a daughter, Frances (Mrs. Charles Cuppett).

Louis Gilmore Robinson (1883–1956), owner, Louis G. Robinson Laboratories, Cincinnati, Ohio, died July, 1956. Born, Cincinnati, Ohio, April 14, 1883. Parents, LaFayette Gardner and Amalie (Autenrieth) Robinson. Education, ME, Ohio State University, 1905. Married May Jones, 1921; children, Landon and Jane. Jun. ASME, 1905; Mem. ASME, 1918. Mr. Robinson, in 1907, organized his own consulting and commercial laboratory for metallurgical and chemical services, analyses, and testing.

Gerald Alan Siron (1935–1957?), research engineer, Caterpillar Tractor Co., Peoria, Ill., died recently according to a report received by the Society. Born, Sedalia, Mo., July 28, 1935. Education, BS(ME), Missouri School of Mines, 1957. Assoc. Mem. ASME, 1957.

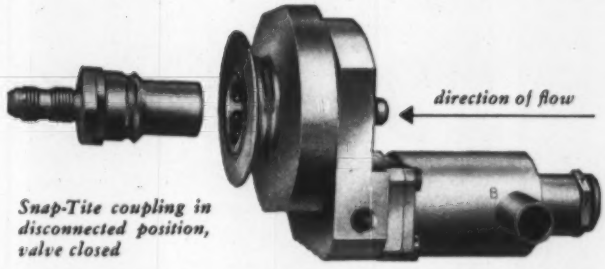
Alton Lincoln Smith (1867–1957), professor-emeritus, drawing and machine design, Worcester Polytechnic Institute, Worcester, Mass., died Oct. 31, 1957. Born, Mattoon, Ill., July 31, 1867. Parents, James Lyman and Sophia Elizabeth (Pfeffer) Smith. Education, BS, Worcester Polytechnic Institute, 1890; MS, 1899; hon. DE, 1947. Married Mabel Hartshorn, 1894 (died 1933). Mem. ASME, 1904. Professor Smith began teaching at WPI in 1890; in 1923 he became assistant to the president of that institution, and he remained in that post until 1937 when he retired. He was the author of a work on technical sketching for engineering students. Survived by two daughters, Mabel Elizabeth Smith of Worcester, and Eleanor H. (Mrs. Arthur K. Ingraham), Oakland, Calif.

Lloyd Lyman Smith (1879–1957), associate, Paul A. Laurence Co., Minneapolis, Minn., died Dec. 15, 1957. Born, Brighton, Mich., May 26, 1879. Education, BS(EE) and MS(CE), University of Wisconsin. Mem. ASME, 1920.

Winfred Henry Stueve (1885–1957), consulting engineer and formerly executive assistant, Oklahoma Gas and Electric Co., Oklahoma City, Okla., died Dec. 8, 1957. Born, Wapakoneta, Ohio, Aug. 5, 1885. Parents, Clement Augustus and Mary (Dickman) Stueve. Education, attended Notre Dame University; ME(EE), Ohio State University, 1908; ME, 1936. Married Eleanor V. Eberle, 1919; two children, Anne Terry and Charles Clement Stueve. Mem. ASME, 1930; Fellow ASME, 1947. Mr. Stueve began his career with Muskogee Gas and Electric Co., of which he became president and manager. He then served as a lieutenant (jg) in the U. S. Navy during World War I. After the war he joined the Empire Electric Supply Co. as a vice-president. In 1925, he joined the Oklahoma Gas and Electric Co., from which he retired in 1950 to become a consultant to several major oil and pipeline companies. Among the honors which he received was a professional degree in mechanical engineering, one of the highest conferred by Oklahoma Institute of Technology. The degree was granted for his work in promoting the use of centrifugal compressors used to transmit natural gas in the "Big Inch" systems. He had acted as chief electrical engineer for the War Emergency Pipelines, Inc., during the construction of the two major pipeline systems, "Big Inch" and "Little Inch." He had written considerably in trade magazines and had published more than fifty articles in various trade journals. He served the Society as a member of the Executive Committee of both the Mid-Continent Section and the Petroleum Division. Member Tau Beta Pi.

William Clark Wall (1868–1957?), whose death recently was reported to the Society, had been foreman of the Stanley Works, New Britain, Conn. Born, Broadbrook, Conn., Nov. 16, 1868. Assoc-Mem. ASME, 1920; Mem. ASME, 1935. Mr. Wall had been engaged in the planning, design, and installation of steam, water, fire-protection, and plumbing work for process plants during a career which began in 1889.

SNAP-TITE REMOTE CONTROL COUPLINGS FOR GUIDED MISSILES



Snap-Tite coupling in disconnected position, valve closed

Here is a specially designed Snap-Tite quick-connect, quick-disconnect coupling, ideal for use in missile-fueling systems. This unit is specifically designed to be manual-connected . . . can also be disconnected manually, or by use of an air-actuated remote control.

NOT A DROP SPILLED!

When the coupling is disconnected, it spills only that small amount of fluid which clings to the metal. The valves in both the coupler and nipple automatically shut off when disconnected, *with no leakage.*

NO AIR INCLUSION!

Coupling operation encloses only a minute amount of air.

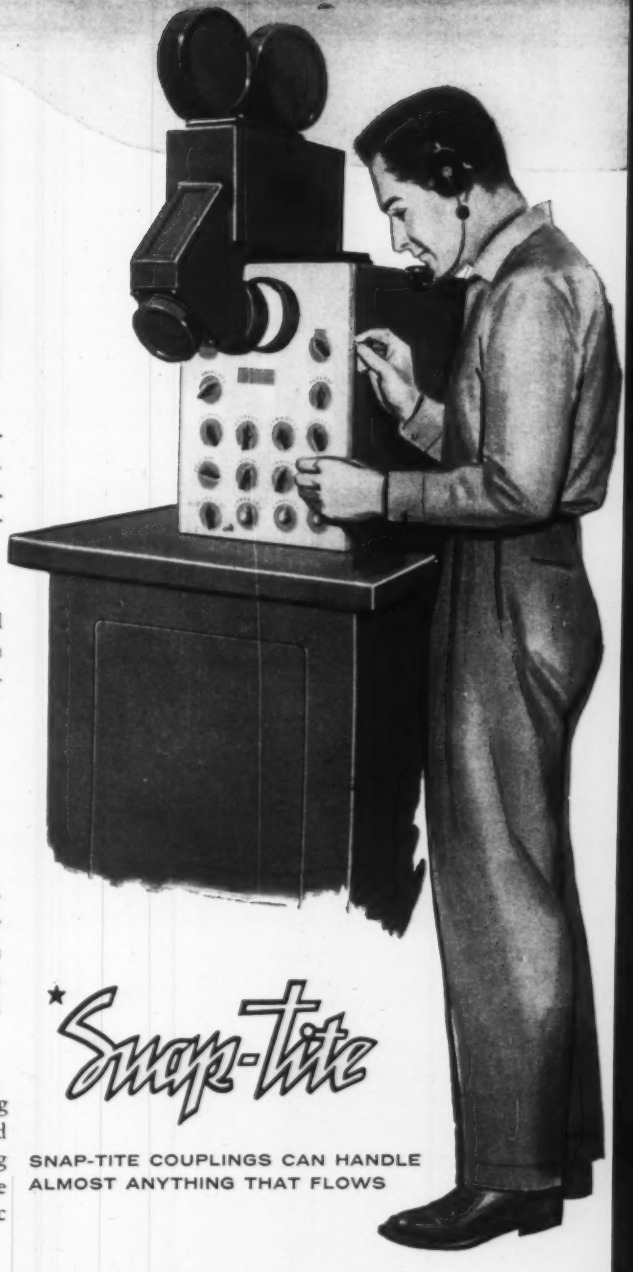
MINIMUM PRESSURE DROP!

Smooth, streamlined passages assure maximum flow.

Variations of this coupling, to meet your required specifications, can be furnished with the appropriate seals to handle liquified gasses, exotic fuels, and a large variety of fluids with working pressures up to 3,000 PSI and temperatures from −300°F to +400°F. Units have been designed up to and including 5″ size.

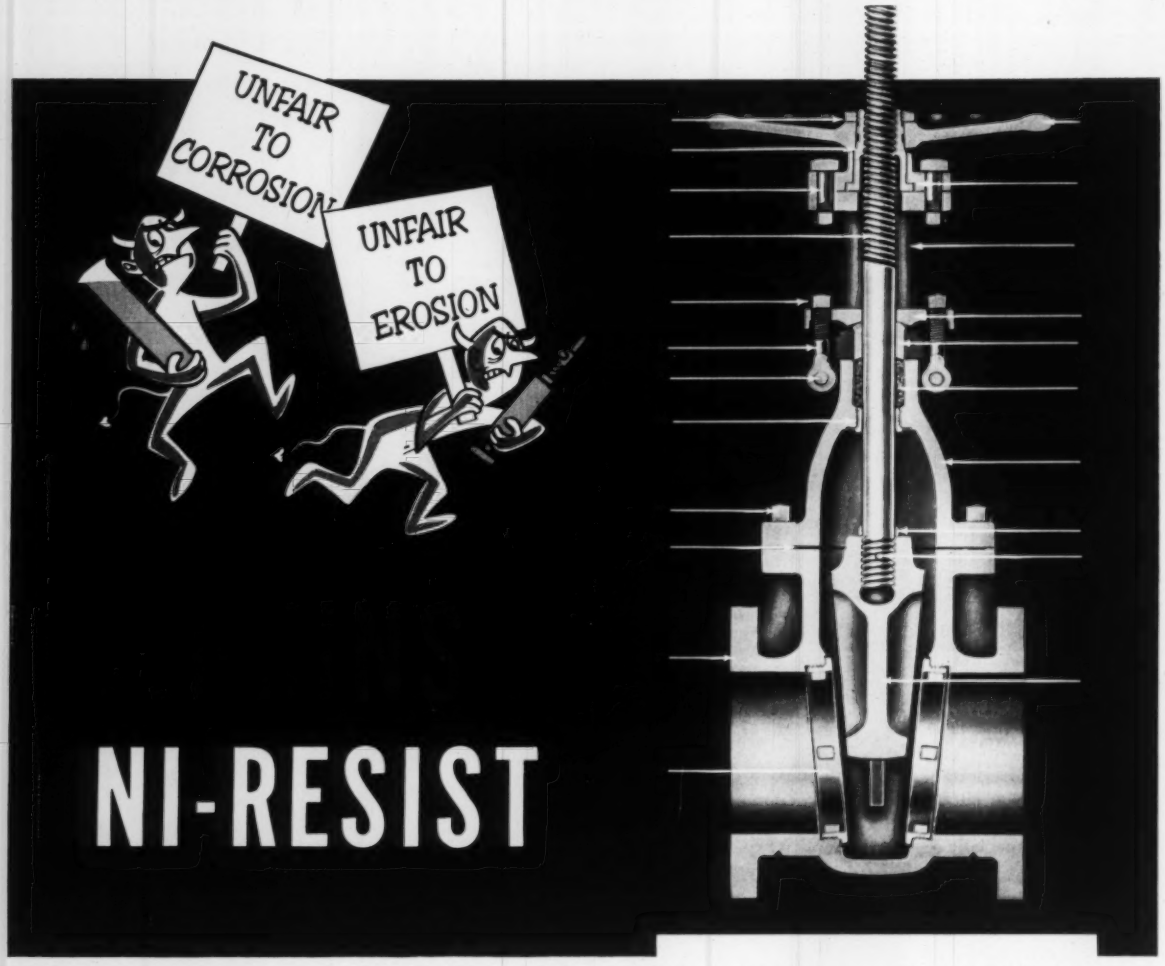
STANDARD COUPLINGS, TOO!

Your coupling needs might not be as critical as the coupling shown here, but you can be sure, when buying standard Snap-Tite couplings, that the same outstanding engineering and manufacturing skills are basic throughout the Snap-Tite line. Write for complete catalog . . . or describe your specific coupling problems. Snap-Tite, Inc., Union City 4, Pa.



★Snap-Tite

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS



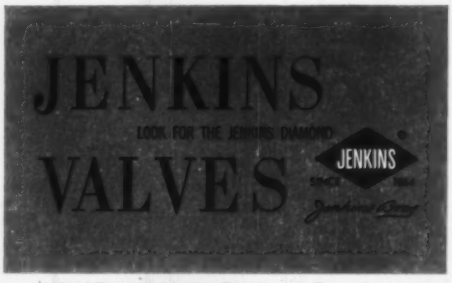
A Bronze yoke bushing nut
B Handy grip iron wheel
C Bronze yoke bushing
D Iron yoke cap with zerk fitting for lubricating bushing
E Steel yoke cap bolts and nuts
F TYPE 316 STAINLESS STEEL spindle
G NI-RESIST CAST IRON, TYPE 2, yoke
H Bronze eye bolt nuts
I Malleable iron gland flange
J Steel gland eye bolts
K Steel gland lug bolts and nuts
L TYPE 316 STAINLESS STEEL gland
M Teflon impregnated asbestos packing
N TYPE 316 STAINLESS STEEL bonnet bushing
O NI-RESIST CAST IRON, TYPE 2, bonnet
P Steel bonnet bolts and nuts
Q TYPE 316 STAINLESS STEEL spindle ring
R Asbestos gasket
S TYPE 316 STAINLESS STEEL wedge pin
T NI-RESIST CAST IRON, TYPE 2, through-port body
U TYPE 316 STAINLESS STEEL solid I-beam wedge
V TYPE 316 STAINLESS STEEL seat rings

Wherever valves are attacked by acids, salt and alkaline solutions, sea water, brine or other corrosive fluids, vapors or gases, "Jenkins Ni-Resist Gate Valves" are *fighting* words.

In a wide range of corrosive and erosive services common to the chemical, food, plastics, marine, petroleum, and pulp and paper industries, these valves have shown a remarkable ability to withstand corrosion and cut valve costs.

The secret of their long, trouble-free service is the combination of Ni-Resist type 2 cast iron and type 316 stainless steel trim, plus Jenkins *extra value* construction throughout. No other gate valves offer this combination for fighting corrosion.

When choosing Ni-Resist valves, let the famous Jenkins Diamond be your guide. Specify "JENKINS NI-RESIST" — for longer valve life. Write us, or ask your Jenkins Distributor for information folder No. 205. Jenkins Bros., 100 Park Avenue, New York 17.



Sold Through Leading Distributors Everywhere

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Available literature or information may be secured by using convenient Reader Service Card on page 183

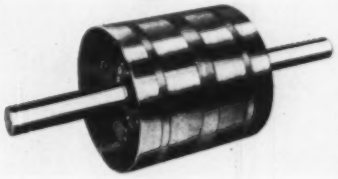
NEW EQUIPMENT

Hydraulic Pumps

A new line of 11-cylinder hydraulic pumps has been announced by Vickers Inc. Both fixed and variable displacement pumps will be available in a complete range of sizes.

First of the series is the fixed displacement Model PF-1110 which is capable of delivering 15.8 gpm at 6220 rpm. This 11-cylinder unit is nominally a 3000 psi pump but can be used for 4000 psi operation with a rated life of 750 hours. It is available with a different bearing configuration for 4000 and 5000 psi operation. Variable displacement units of the same size also have been delivered, the company reports.

Design features include a high-strength cast aluminum alloy housing with an elastomeric seal bonded to the cover for prevention of leaks at elevated operating temperatures. All bearings have fully metallic caged balls or rollers. Materials in the new 11-cylinder pumps are the same as those used in the firm's high temperature pump development that has produced a pump capable of operation at 450 F under test conditions of 3000 psi discharge pressure and 3600 rpm. Additional features include pressure compensation which provides constant pressure without variation and temperature compensation to avoid pressure sag at elevated temperatures. —K-1



Ceramic Magnet Pulley

Stearns Magnetic Products announces a magnetic pulley in which Indox V ceramic permanent magnets energize it to produce a powerful magnetic field that effectively removes tramp iron from fast-moving conveyor burdens.

The new permanent magnet pulley is reported to equal the performance of electromagnetic types, and is superior to conventional permanent magnet models.

The unit has radial pole design of the magnet assembly to boost holding efficiency without the disadvantages of electrical power supply.

Series 410 permanent magnet pulleys and Series 710 for deeper conveyor burdens are available in standard widths from 12 in. up, and in diameters of 12, 15, 18, 20 and 24 in. —K-2

Variable Speed Drive

A new infinitely variable-speed drive, called Marvex, using constant-speed motors and designed around the eddy-current principle, is announced by Cone-Drive Gears, Div. Michigan Tool Co.

Initially, four drip-proof models in six different sizes are available. Models include a separate controlled-slip coupling and various combinations to serve as variable-speed gearmotor, variable-speed motor, and special unit for integral mounting of speed reducers. They will handle motors up to 150 hp at 1750 rpm. Maximum torque transmittal is 450 ft-lb. Direct current power supplies are not required, the firm states.

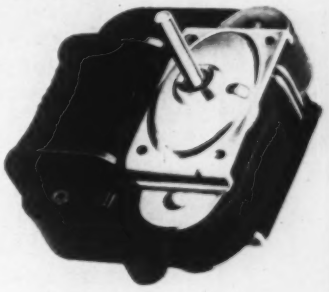
According to the company, the unit provides an infinitely variable-speed drive from a constant-speed source, and eliminates motor-generator sets. There is no mechanical connection between prime mover and load, and the only coupling is a magnetic field. It gives gear drives a Class I rating by eliminating the shock load factors, and the load can be engaged or disengaged electromagnetically without stopping the prime mover. Use of mechanical clutches is eliminated, the company claims. —K-3

PVC Piping Flanges

Tube Turns Plastics Inc. announces replacement of its existing line of smooth-face flanges with what it describes as the industry's first complete line of flanges with concentric-serrated faces for polyvinyl chloride piping systems.

The company cites better gasket retention, a more effective seal and improved appearance for its switchover from smooth-face to serrated-face flanges. It explains that by adopting concentric serrations instead of the "phonograph record" type of spiral serrations, it eliminates the chance of a fluid traveling around the spiral grooves between serrations until it eventually leaks from the flange. With concentric serrations the fluid is sealed off at the first serration.

The new flanges, having approximately 32 serrations per inch, will be produced in sizes from $1/2$ through 6 in. in both socket and threaded types and in both normal and high impact material. —K-4



A-C Motor

Barber-Colman Co. has added a new low-cost, precision-made a-c motor to its extensive line.

Some of the features of the motor include long-life alignable bearings, large oil reservoirs with optional auxiliary oil cups, high starting torque and low noise level.

Stack thicknesses of $9/16$ and $15/16$ in. and shaft diameters of $1/8$ and $5/32$ in. are available. Horsepower ratings are to $1/150$. —K-5

CORRECTION

The story headlined "Load Socket" on page 157 of the May issue of MECHANICAL ENGINEERING incorrectly identified the manufacturer of the socket as Pace Engineering Co. instead of Page Engineering Co. of Chicago, Ill.

Official U. S. Navy Photograph

when all MANKIND...

is gazing at the heavens wondering if its bleak and silent spaces will be friend or foe, our Nation's security depends, more than ever before, on the Engineers' and Scientists' determination to make major scientific break-throughs rather than mere improvements in existing hardware. The professional staff of the Vitro Silver Spring Laboratory is dedicated to this goal.

Our present openings are few but extremely challenging. For detailed information, address your inquiry to:

Manager, Professional Employment
Silver Spring Laboratory, Dept. 302
Vitro Laboratories
14000 Georgia Avenue, Silver Spring, Maryland

Vitro LABORATORIES
Division of the Vitro Corporation of America

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Temperature Relief Valves

Cash-Acme Automatic Valves announces a new series of temperature-only automatic relief valves.

Designated the Type TR series, they provide temperature protection for hot water tanks and heaters already protected by a pressure-only relief valve, since both pressure and temperature protection are necessary to prevent explosions.

The Type TR valves are constructed of bronze castings with brass internal parts, silicone seat disk, and a positive acting thermostat which opens the valve at 210 F, and closes it at 180 F. Maximum pressure is 150 psi. Available in eleven models, all A.G.A. listed, meets Type 2 requirements of Military Specification MIL-V-13612 as amended. **—K–6**

Silicone Fluid

A new low viscosity silicone fluid for use as a damping medium and hydraulic fluid has been introduced by the Silicone Products Dept., General Electric Co.

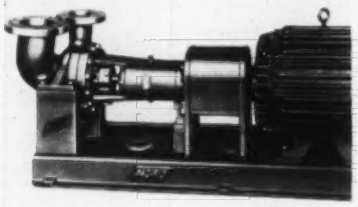
Available in 5, 10, and 20 centistoke grades, fluid 81743 has a lower viscosity-temperature coefficient and lower pour point than most methyl silicone fluids, it is reported.

Suggested uses for this compressible fluid are as a damping medium in vibration dampers, shock absorbers, dash pot relays and timing relays, and as a hydraulic fluid in servomechanisms, accelerometers, instruments, and other control devices.

In common with other silicone fluids, 81743 is highly resistant to shear breakdown and possesses unusual chemical resistance. Because of its low viscosity, it offers somewhat more rapid response than the standard silicone fluids of higher viscosities, the firm states. **—K–7**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Centrifugal Process Pumps

Pacific Pumps, Inc. announces its new SVA line of 21 pumps, divided into four size groups having 20 major parts interchangeable within each group.

The new single stage pumps feature a double wearing ring impeller, angular contact thrust bearings, a mechanical seal or conventional packing. The rotating element—shaft, shaft sleeve, impeller, wearing rings, head, packing gland, bearings and housings—form a completely unitized assembly. This simplified design provides rapid dismantling and reassembly, the firm states.

Developed for economical transfer of hydrocarbons, chemical solutions, acids, and condensates, the pump has a capacity of 15 to 1600 gpm at a working pressure of 500 psig, a differential head of 700 ft, speeds of 3600 rpm and temperatures to 300 F.

—K–8

Textile Rolls

Two textile rolls have been announced by Manhattan Rubber Div., Raybestos-Manhattan, Inc.

The rolls are known as Textractor and Texroc and are used in extracting liquids on mangles, mercerizers, wringers, ranges, and other dye and bleachery operations.

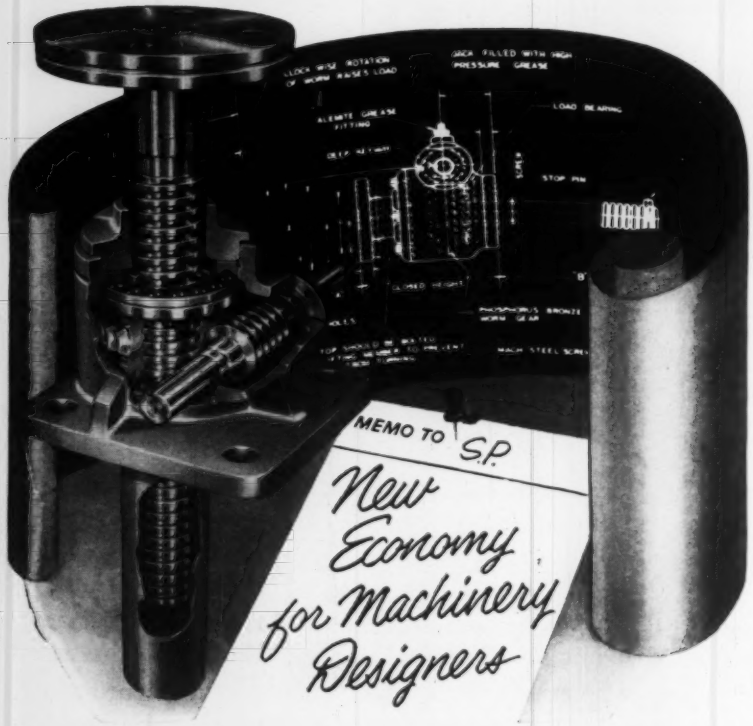
The Textractor roll is reported to be more crack-resistant and to extract more water than conventional rubber covered rolls, and the cushion-like nip prevents crushing. Cloth crushing as usually experienced with ordinary rolls is eliminated. The Texroc roll is described as an entirely new type of hard white rubber roll that extracts up to 10 per cent more water than metal rolls, minimizes chemical and dye build-up and eliminates pitting. The manufacturer claims both permit maximum and uniform edge-to-edge water removal and have longer roll life.

—K–9

Use a CLASSIFIED ADVERTISEMENT
for Quick Results

When fewer men must do more work . . . Hamilton Auto-Shift (above) and L Contour tables (below) set the pace by speeding up board movements. Two simple controls allow tilt and vertical adjustment which brings board area within easy reach whether sitting or standing! Convenient reference area (behind draftsman on Auto-Shift, at right or left on L-table) keeps board clear, saves checking time, insures accuracy. Get complete details from your Hamilton dealer or write Hamilton Manufacturing Company, Two Rivers, Wisconsin.

Hamilton



NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-FF, which includes drawings and full specifications.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

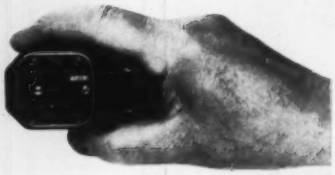
DUFF-NORTON JACKS
Ratchet, Screw,
Hydraulic, Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever
Spur Gear, Electric

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Vibration Pickup

MB Mfg. Co. announces its Type 128-1 vibration pickup for air-to-surface missiles. In operation in recent tests, each flight carried as many as seven pickups, and data was recorded at ground stations using telemetering techniques, the company reports.

Using the basic design of the standard its velocity type pickup, the magnetically damped Type 128-1 has special features said to make it suitable for use in measuring vibratory motions with up to ±5g unidirectional steady acceleration superimposed, with little change in sensitivity over a wide temperature range (−65 to +250 F).

The pickup is claimed to be useful not only in measuring the higher frequency vibratory accelerations of a missile as it performs its flight maneuvers, but also in measuring low frequency jerk (the third derivative of displacement with respect to time). —K-10

Electro-Hydraulic Valve

A new servo valve designed for industrial and ground ordnance applications has been announced by Vickers Inc. It is designed to fill the gap between hydraulic power and electronic programming of control functions.

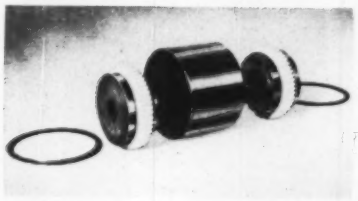
The firm reports that the unit provides extremely accurate flow modulation required for the closed loop, program controlled combinations of position, velocity, and acceleration.

The two-stage valve has four moving parts: main spool, control spool, sleeve, and feedback linkage. The mechanical feedback linkage with variable fulcrum is designed to make the valve highly flexible and compatible with various conditions of flow, response, and pressure. Only a small signal, in the milliamp range, is required for control.

Valve design provides for maximum tolerance to foreign particles that may be present in a hydraulic system. The new servo valve is rated at 10 gpm maximum flow at 1000 psi (assuming 1/3 pressure drop across valve) and operates on supply pressure up to 3000 psi. By means of the mechanical feedback linkage the valve can be trimmed to handle 10 gpm with as little as 300 psi supply pressure. It can be gasket or subplate mounted or manifolded to a hydraulic motor. —K-11

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Gear Coupling

A versatile, new coupling which can take up to 1800 in.-lb torque is now being produced by the John Waldron Corp.

Designated the 162M the coupling does not need lubrication and has interchangeable bushings.

Stress relieved, injection molded nylon gears make possible the no lubrication feature, the firm reports. The gears, which are held in place on the steel hubs by spring rings, make a smooth, resilient contact with the steel sleeve.

The interchangeable bushings are available for shaft sizes from $^1/_2$ to $1^5/_8$ in. Steel hubs, a steel sleeve and spring rings complete the unit. **—K–12**

Oil Heaters

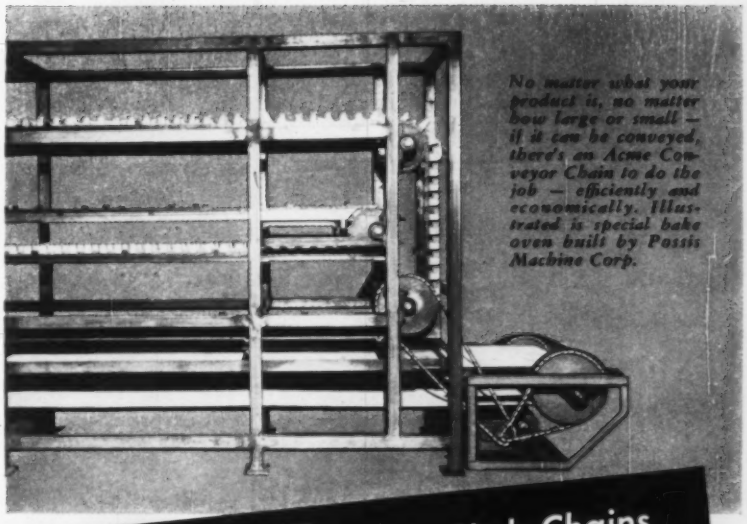
A direct fired oil heater for heating transfer oils or other liquids to temperatures up to 600 F has been announced by Cleaver-Brooks Co.

The heat transfer oils may be circulated through coils, molds, jacketed vessels, and other heat exchange equipment to provide higher temperatures than can be economically obtained with high pressure steam.

Forced internal circulation design of the new Peak-Temp oil heater provides high velocity flow of the heat transfer oil over the heating surfaces. Uniform oil temperature eliminates hot spots, coking or deterioration of the heat transfer oil. A simple fire brick ring in the burner throat is the only refractory used in this new design. Applications for the heater are for the asphalt, chemical, plastic, oil refinery, textile industries.

The heater is fired with oil, gas, or combination oil/gas. The heater is of the closed type and is the horizontal fire-tube design. This factory fire tested unit is a complete package with removable heater element, integral forced draft fan and burner, and operating and safety controls. Heater element has a large vent at the top of the shell. The heater is used with the expansion tank and external circulating set.

Burners are available for either gas, oil, or combination, operate with full modulation through potentiometer type positioning controls. The burner always returns to low fire position for ignition. A modulating thermostat senses the oil temperature in the heater and controls the burner firing rate. A separate thermostat controls the operation of the internal propeller. **—K–13**


No matter what your product is, no matter how large or small — if it can be conveyed, there's an Acme Conveyor Chain to do the job — efficiently and economically. Illustrated is special bake oven built by Possis Machine Corp.

Why ACME Double Pitch Chains and Sprockets are being recommended more and more for Conveyor Work

Acme Conveyor Chains and Sprockets are being recommended in more and more industries because they are high-grade, precision finished, roller chains and are available at lower cost than standard pitch chains. The lower cost of Acme conveyor chain is possible because standard chain parts are used in the manufacture of our double pitch chain.

DOUBLE Duty tooth form Sprockets further reduce costs by doubling conveyor life.

This cost reduction is possible by simply advancing the sprocket one tooth after long service has worn the original teeth.

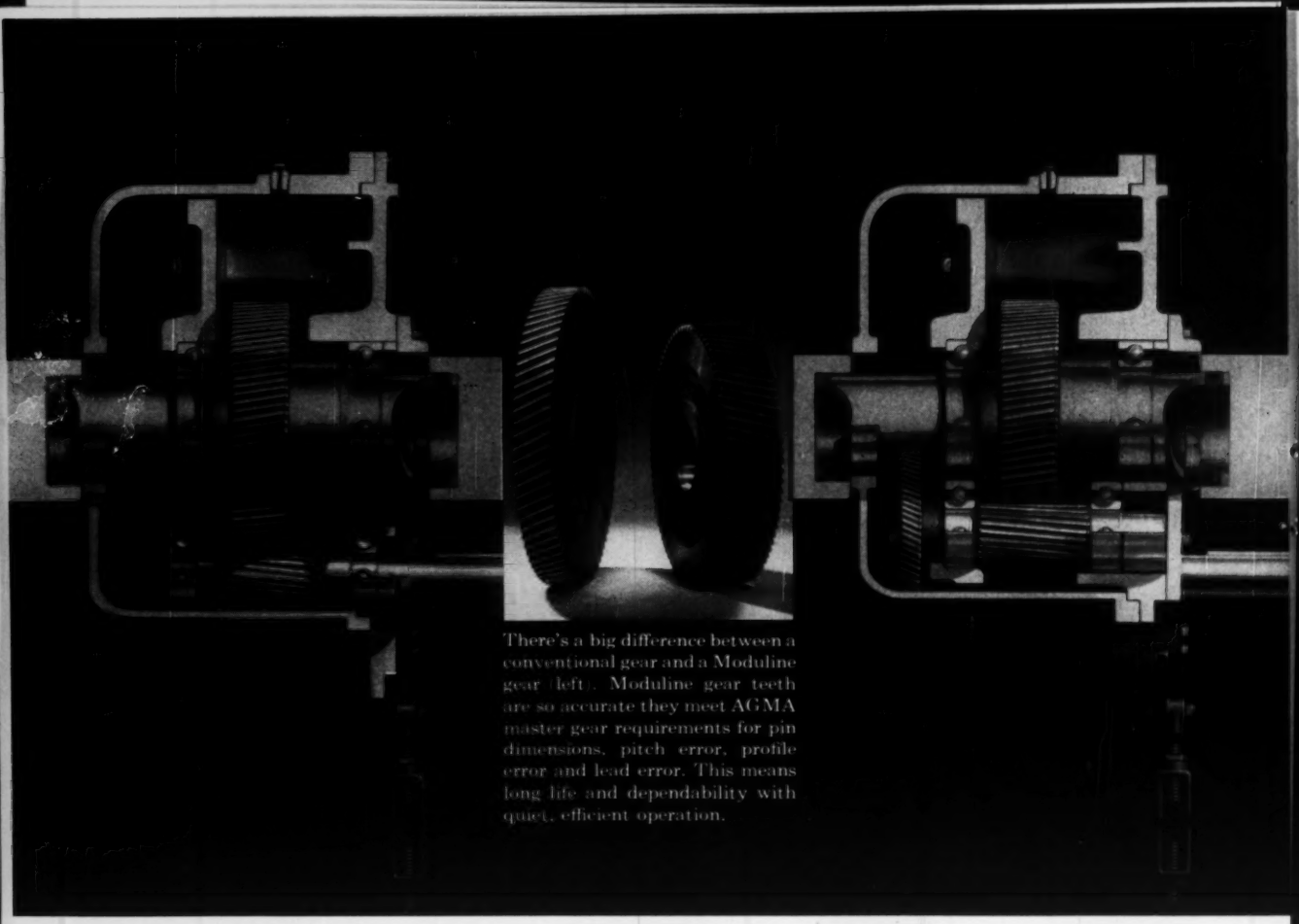
A complete line of available attachments gives Acme conveyor chain customers great versatility and economy in the planning and operation of their conveyor lines. Acme field engineering service is yours for the asking to help solve conveyor problems.

Write Dept. IIQ for new illustrated 100 page catalog which includes new engineering section showing 36 methods of chain driving.

Call ACME for Service

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS



There's a big difference between a conventional gear and a Moduline gear (left). Moduline gear teeth are so accurate they meet AGMA master gear requirements for pin dimensions, pitch error, profile error and lead error. This means long life and dependability with quiet, efficient operation.

KEEP INFORMED

Response Tracing System

A subsonic response indicator has been introduced by Panoramic Radio Products, Inc.

Used in conjunction with the firm's subsonic spectrum analyzers, Model LF-1 and LF-2, the new Model G-5 analyzes frequency response characteristics of servo amplifiers, filters, acoustic reproducers, transformers, shaker tables in the low frequency range from 0.5 to 2250 cps.

The firm says it is helpful in locating resonant frequencies in mechanical structures and is particularly valuable in testing networks and devices which tend to produce distortion products, where hum and noise are present, and where measurements through large dynamic ranges are necessary.

Serving as a synchronous sweep frequency generator, the unit shows on the pen and ink recorder single line response to fundamental frequency only, discriminates against noise and hum and has virtually unlimited dynamic range, the company reports.

The automatic linear excursions of 20, 100 or 500 cps may be centered at any point in range from 0.5 to 2000 cps. Use of a spectrum analyzer in curve tracing permits precise marker pips to be inserted by means of a signal generator, it is stated. **—K-14**

Temperature Control Valves

A plastic coated sensing bulb and thermal system is now available with all sliding gate temperature control valves produced by OPW Corp.

For use in plating tanks, chemical tanks or heaters, and other corrosive applications, the system is heavily coated with a protective, heat conducting plastic film. It is said to be suitable for temperatures up to 185 F.

Capillary tubing is available in 8, 15 ft, and special lengths. The valves are available in sizes $1/4$ through 2 in. **—K-15**

Vibrating Screen

A new heavy duty Straightline horizontal vibrating screen, CL-Model 58, has been announced by Link-Belt Co.

Designed for dewatering, washing, and sizing a variety of materials where head room is limited, the new horizontal screen can be cable suspended or floor mounted. Where conditions warrant, a combination of both mountings can be used, the firm reports.

The screen achieves a high intensity motion by centrifugal force, unbalanced shaft vibrators. Two eccentric shafts in the vibrator, supported by heavy duty oversize self-aligning bearings, are rotated by a helical gear speed reducer, giving the screen its straightline motion. **—K-16**

Packaged Boiler

Western Boiler Co., 1600 N. Indiana St., Los Angeles 63; announces its new line of completely packaged steam generators available for firing all grades of fuel oil, gas, or combination oil-gas.

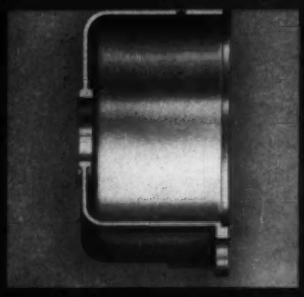
The boilers are of three-pass design, and are available as forced draft, induced draft or pressure forced draft units. Forced and induced draft ratings range from 25 to 600 hp while pressure forced draft models run from 10 to 100 hp. **—K-17**

Spring Tester

A new spring tester, described as a precision instrument for checking loads and deflections of compression and extension springs, has been announced by Carlson Co., 3457 Weidner Ave., Oceanside, N. Y.

It is useful for receiving inspection, production checking and general use, the company reports. Up to 600 tests per hour have been made. Loads are shown on a 15-in. diam dial by turning a handwheel, and lengths are indicated on stainless steel rules in fractions of an inch and in decimals.

The unit is designed to handle loads $1/2$ to 300 lb, spring diam up to $4\text{-}1/2$ in., spring lengths $1/4$ to 12 in. A dial indicator can be applied to register deflections in thousandths of an inch, the firm states. **—K-18**



Sturdy aluminum cover means weight savings and quietness.

Moduline cold-rolled splined shafts have optimum grain structure for extremely high strength. An elastic stop nut mounts on a rolled thread of the shaft and holds gears and pinions in place axially. These splined shafts assure accurate alignment and serviceability.

MODULINE

IS ORIGINAL IN VERSATILITY—DEPENDABILITY

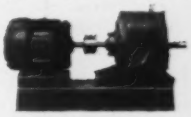
Westinghouse has master gear quality for shaft-mounted speed reducer applications

Moduline shaft-mounted speed reducer provides original advantages for simplified applications and dependability. For the first time, you can get precision-ground, heat-treated gears for quiet, dependable long life.

Splined shafts afford ease of maintenance and positive mounting of high-speed gears and pinion in double-reduction units. A built-in backstop assures positive prevention of reverse rotation or back run. The backstop can be installed at the factory or easily mounted in the field. The concentric housing offers new compactness.

For detailed information on shaft-mounted reducers and a demonstration of Moduline originality, call your local Westinghouse sales representative, or write Westinghouse Electric Corporation, Gearing Division, 200 McCandless Avenue, Pittsburgh 1, Pa. J-07367

a complete line of . . . . .



speed reducers . . . . . .

gearmotors . . . . . .

and package motor reducer drives . . . . . .

YOU CAN BE SURE...IF IT'S Westinghouse

POWER-UP! with MODULINE

KEEP INFORMED

High Strength Bronze

A corrosion-resistant nickel-silicon bronze alloy said to combine both high yield strength and high ultimate tensile strength even at elevated temperatures has been developed by Chase Brass & Copper Co.

The new alloy, called Silnic bronze, is age hardenable and is available in soft, cold forming, and hard tempers. Age hardening of the alloy is a rapid, inexpensive treatment at 900 F for 90 min.

The alloy in the cold forming (solution annealed and drawn) temper is said to permit easy material flow for fabrication involving severe or complicated cold working. Subsequent age hardening gives the final high strength, hardness, and conductivity to the nickel-silicon-bronze alloy. The alloy will not age-harden spontaneously at storage temperatures.

Purchased in the hard temper, the bronze can be machined or given moderate cold working without further treatment. It gives extremely good chip breakage and accurate detail when machined, the company says.

The new alloy has about five times the electrical conductivity of bronze alloys presently used for high strength, high corrosion applications. It is free from silicon segregation, with its resultant planes of weakness, which is common to high-silicon bronzes. —K-19

Proportioning Pump

Hills-McCanna Co. has announced the development of a new, more compact model of its metering and proportioning pump.

Called the integral McCannameter, it takes only 1/3 the space previously required. This packless pump has continuous flow characteristics available through the entire capacity range. Capacity is adjustable while in operation, pumping at pressures up to 2500 psi. The unit is available with either Teflon-faced diaphragm or metallic bellows. —K-20

Air Oil Cylinders

A line of newly designed air and oil cylinders for industrial, mobile farm applications has been announced by Hemco Mfg. Inc.

The new line is offered in 8 bore sizes: 1 1/2, 2, 2 1/2, 3, 3 1/2, 4, 5, and 6 in. incorporating 10 different mounts: clevis, eye, tube, front flange, rear flange, rabbit, pilot, centerline, side lug, and foot mount.

Cylinders can be supplied with either O-ring seals for pressure up to 2000 psi or cups and Twin Pak packings for pressure up to 3000 psi, the company reports. Stroke lengths are available up to 10 ft as standard.

The firm states that its new farm cylinders meet ASAE specifications and are offered in 2, 2 1/2, 3, 3 1/2 and 4 in. bore sizes. —K-21

Solenoid-Operated Lubricator

A solenoid-operated lubricator developed to distribute lubricating oil from a self-contained reservoir or from reservoirs in the machine itself is described in a technical reference offered by Bijur Lubricating Corp.

Sheet describes Type E which is available with 3-terminal float switch and 6-pint reservoir. It is actuated by a solenoid within a sturdy casing requires no mechanical linkage. —K-22

Precision Drilling Machine

A precision drilling machine to eliminate height gage layout and common errors in drilling sheet metal templates has been developed by Wales-Strippit Co.

By means of a precision ground lead screw and dial which can be read to .001 in., measurements can be made to a high degree of accuracy, the company reports. The dimension setting is positively locked during drilling. The firm states that wear on the lead screw is minimized because it is used only for setting dimensions; movement of drill carriage taking place rapidly from hole to hole, manually, lead screw disengaged.

A base line is established anywhere within the 24 × 24 in. table by adjusting the zero position of built-in flexible tape which can be read to right or left from zero. —K-23

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Plastic Valve Operator

An all-plastic molded valve operator which contains no metallic parts has been developed by Chemtrol Div., Tapered Air Products.

The unit is designed for contemplated or existing plastic piping systems carrying corrosive liquids.

The valve operator is designed for use in most instances where metal operators are now employed. The unit is approximately one-tenth the weight of its metal counterpart and is said to be easily disassembled for cleaning or part replacement.

It has a safety factor of 5 to 1 and it will operate at pressures of 15 psi with the corrosive mother liquid as the pressure agent. However, when the operating pressure is that of the mother liquid, in no case will the valve operator function on pressures in excess of 150 psi. The valve operator is constructed to withstand temperatures to 300 F.

Materials from which the operator valve may be constructed vary according to individual use. **—K-24**

True Airspeed Computer

A new true airspeed computer, designated SMI Type AXC 529, has been designed by Servomechanisms, Inc. to provide true airspeed input to airborne navigational systems. The computer is said to have an accuracy of ±2 knots in a range of from 100 to 250 knots.

According to the firm, these accuracies are possible through the utilization of a highly accurate and sensitive force balance Mach number transducer which generates a shaft position functionally proportional to Mach number.

The design stresses modular construction, computational accuracy, computational reliability and simplicity of operation, the company states. Each major function is accomplished in a separate, plug-in unit. The plug-in, plug-out design is to reduce downtime to a minimum and enable semi-skilled personnel to maintain the equipment by simple substitution of the plug-in modules, the firm reports. **—K-25**

Orienting Parts Feeder

Feedall, Inc., Willoughby, Ohio, announces a special Model 2200B elevating conveyor and automatic parts feeder designed to handle up to 200 ball sockets per minute, orienting and feeding them into a production machine. According to the firm, feed rate can be adjusted by the moving conveyor which has a variable speed drive. Low loading height and 4 cu ft capacity of the hopper are designed to afford simple conveyor loading and available parts storage.

The unit is entirely self-contained, has a $^1/_2$ hp 3-phase 1800 rpm motor, and variable speed drive with power take-off at right, or left, or both sides. Angle of conveyor elevation, depth of cleats and orienting position can be varied. Other features include complete automatic operation, heavy steel plate construction.

In addition to ball sockets, the unit is portable and may be adapted to feed a wide range of rolling or sliding parts. **—K-26**

Micaceous Insulation

Development of a new family of epoxy resin-bonded micaceous insulation for use with Class B electrical equipment has been announced by Mica Insulator Div., Minnesota Mining and Mfg. Co.

Designated "Isomica-epoxy" brand micaceous insulation by the firm, it combines Samica reconstituted mica with epoxy resin binders. The resulting material is characterized by outstanding heat and chemical resistance, high electrical properties, extreme uniformity in thin sections and good mechanical strength, it is reported.

The new insulation is available in rigid and flexible forms. The rigid forms include segment plate, molding plate and tubes, while the flexible forms include slot liners, sheets, tapes, and combinations. Molded V-rings, used in commutator insulation are also available; but, the firm says, these are made with regular mica splittings which provide the stretch needed during assembly operations. **—K-27**

1956 MANUAL OF CONSULTING PRACTICE FOR MECHANICAL ENGINEERS

A Guide for Consulting Engineers and Their Clients

It sets forth the proper approach in obtaining professional engineering services, in establishing the fundamental structure in engineering agreements, and in setting up conditions applicable to the conduct of engineering assignments under various types of agreements.

CONTENTS Engineer-Client Relationship. Selection of the Engineer on Merit Basis. Engineering Services (Advisory, Appraisals, Management, Production, Inspection or Testing, Design Projects). Contracts for Services. Basis for Making Charges (Annual Retainer Fees, Per Diem, Retainer Plus Per Diem, Lump-Sum, Cost Plus a Fee, Percentage of Cost of Work, Repetitive Work, Mechanical Equipment of Buildings). Principles of Settlement for Delayed or Terminated Projects. Reuse of Plans. Patents. Confidential Data. Canons of Ethics.

$1.50
20% Discount to ASME Members

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 W. 39 St. — N. Y. 18, N. Y.

Controls Development at Marquardt

by Roy E. Marquardt, President

Marquardt was established in early 1944. Concurrently with the early development of the ramjet engine, controls had to be designed which would operate within the ramjet engine under severe environmental conditions.

The extreme velocity and acceleration of the engines created controls requirements well beyond the limits of the turbojets then in development and operation.

Marquardt engineers and scientists solved these early controls problems... creating components which produced reliable performance in the high Mach ranges; and today under Chief Engineer Tony Kreiner have gone on to develop a family of even more advanced controls and accessories:

In rotating accessories, Marquardt's pioneering turbine and pump work has culminated in emergency power units for the Chance Vought F8U-1 Crusader, and the Lockheed F-104 Star Fighter.

In the area of supersonic engine inlets, Marquardt engineers and scientists have been engaged in broad research and development programs for the past ten years. This aero-thermo knowledge coupled with our controls background has led to applications for variable geometry inlet control systems on North American's Hound Dog electronic countermeasures missile and McDonnell's twin-engine all-weather fighter.

And in afterburner controls, exit nozzles, noise suppressors and nuclear controls, Marquardt engineers have and continue to achieve significant engineering breakthroughs.

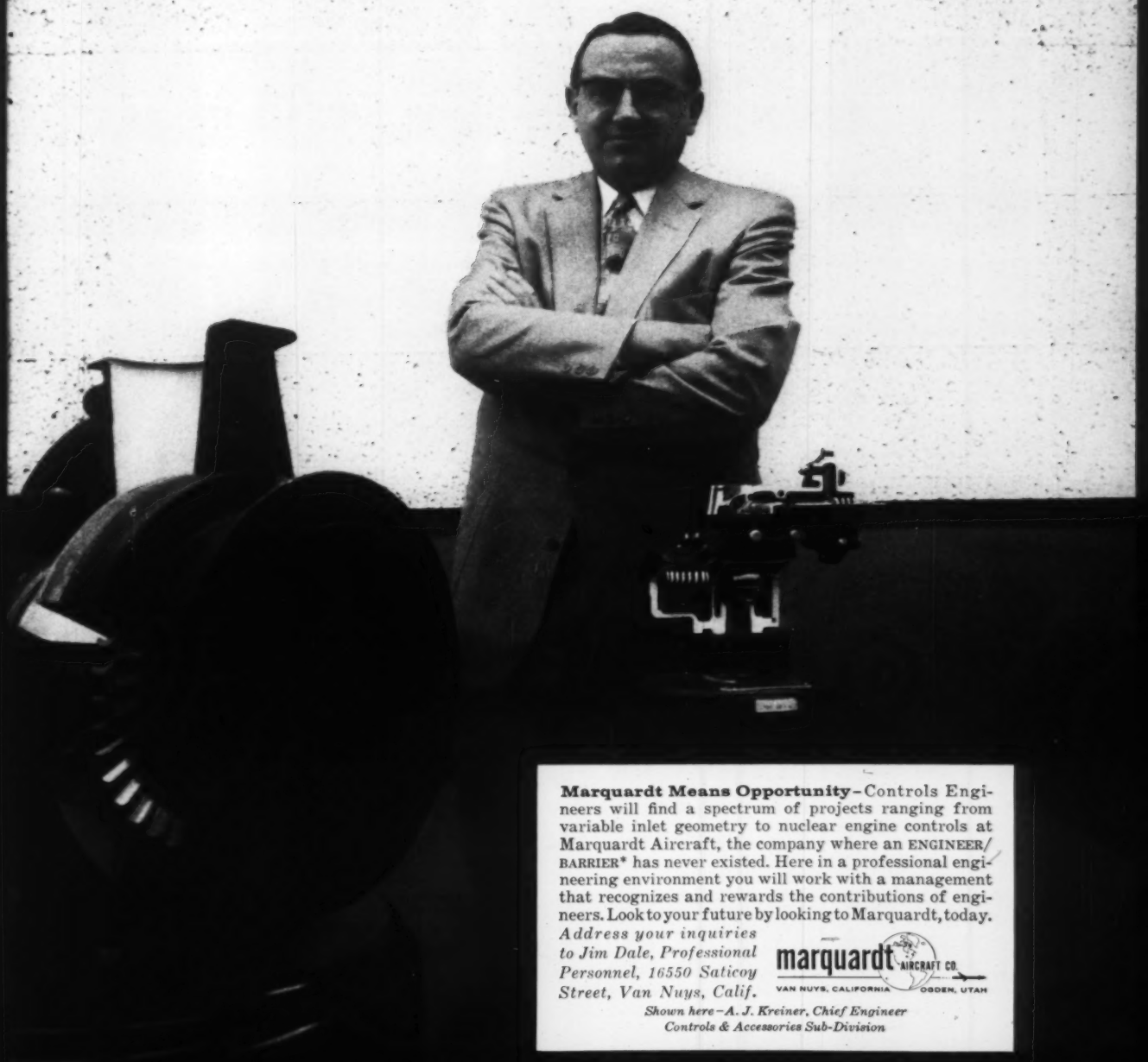
Professional engineers will find a broad range of challenging assignments and projects at Marquardt, plus opportunity to further their careers through supplemental educational programs.

For information about the professional engineering environment at Marquardt, we invite you to contact Jim Dale, Professional Personnel today.

Roy E Marquardt

marquardt AIRCRAFT CO.
VAN NUYS, CALIFORNIA — OGDEN, UTAH
FIRST IN RAMJETS

To Controls Engineers Facing an ENGINEER|BARRIER*



Marquardt Means Opportunity–Controls Engineers will find a spectrum of projects ranging from variable inlet geometry to nuclear engine controls at Marquardt Aircraft, the company where an ENGINEER/BARRIER* has never existed. Here in a professional engineering environment you will work with a management that recognizes and rewards the contributions of engineers. Look to your future by looking to Marquardt, today.

Address your inquiries to Jim Dale, Professional Personnel, 16550 Saticoy Street, Van Nuys, Calif.

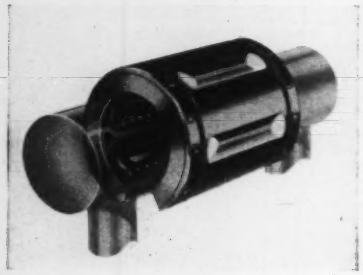
marquardt AIRCRAFT CO.
VAN NUYS, CALIFORNIA · OGDEN, UTAH

Shown here–A. J. Kreiner, Chief Engineer Controls & Accessories Sub-Division

*ENGINEER | BARRIER–an achievement level beyond which you cannot advance

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Linear Ball Bearing

A linear ball bearing has been developed by Thomson Industries, Inc. to permit the use of shaft support members along the length of the shaft traversed by the bearings.

The bearings are known as open type ball bushings and are recommended by the firm where extreme rigidity or unusually long shafts are a requirement.

The open construction of the bearing also permits adjustment of its bore diameter by use of set screws or other clamping arrangements. This feature enables elimination of shake or play by adjusting for a smooth free-running line-to-line or slight preload fit, the company says. **—K-28**

Precision Pressure Calibrators

Wallace & Tiernan Inc., announces improved types of precision aneroid and dial type manometers for portable calibrators of pressure transducers.

Models of the calibrators have absolute pressure ranges starting at zero to 31.5 in. of mercury absolute and extending to as high as zero to 150 in. Differential pressure ranges start at 0 to 120 in. of water and extend to 0 to 300 in. of mercury.

The accuracy of all models is 0.1 per cent of full scale range, the firm states. Readability and sensitivity to pressure change is one part in 10,000. **—K-29**

Oil Field Pump

A power pump for oil field and light duty industrial applications is now being manufactured at Worthington Corp's. Oil City Div.

The model KCA power pump has been primarily developed as an inexpensive waterflood and salt water disposal pump for the oil fields and is manufactured in corrosion-resistant aluminum bronze for these services, the company reports.

Features of the new pump are described as including inter-changeable plungers over widest available diameter range ($1^1/_4$ to $2^1/_2$ in.), straight-flow design, and 3-in. suction and 2-in. discharge on ei her side pipe connections. **—K-30**

Key Openings in Product Design

Vought Design Engineers are working in extremely refined areas on a number of advanced weapons: missiles, manned aircraft and spacecraft. Problems include designing satisfactory environments for man in space — suitable atmosphere, automatic escape provisions, and functional cockpits that integrate inputs and actions for the accomplishment of complex missions. Following are key positions in which creative designers may develop rapidly into well-rounded, systems-conscious candidates for top-level posts:

AIRCRAFT

Cockpit Arrangement. A.E., M.E., E.E., with experience in cockpit or interiors design. Also valuable: industrial design or pilot experience. To develop and design cockpit and crew interiors for advanced aircraft.

Intelligence Display. A.E., M.E., E.E., with instrument design or instrument systems development experience. Useful, too: pilot or human factors experience. To develop and design advanced instrument systems and presentations for pilot and crew.

Cockpit Atmosphere. A.E., or M.E., with experience in air conditioning and oxygen systems design. To develop and design atmosphere systems that comfortably protect air and space crews in vehicles ranging from piston-driven to boost-glide types.

Escape Systems. A.E., or M.E., experienced in design of ejection seats, ballistic devices, pilot retention systems, and high-speed ejection test sleds. Escape capsule experience also desired. To design and develop automatic devices for escape situations ranging from ground level to escape from orbit.

MISSILES

Powerplant Installation Design. A.E., or M.E., with experience preparing specifications and layouts. To design fuel, air induction and accessory systems, and engine mountings.

Design Liaison. Engineering Degree, or equivalent, plus 3 years general design experience and good knowledge of shop loading, fabrication, quality control and material selection procedures. To join and eventually head a liaison team investigating manufacturing problems arising from design.

To arrange for a personal interview, or for more information on these or other current openings, return coupon to:

C. A. Besio
Supervisor, Engineering Personnel
CHANCE VOUGHT AIRCRAFT, Dept. T-3
Dallas, Texas

I am a _____ Engineer,
interested in the opening for _____
Name _____
Address _____
City _____ State _____

Vought Vocabulary

e · con′ o · my: *when round-trip missiles save taxpayers $102,950,000*

Most missiles land head-first – and, like a bomb, just once. This destruction is desired in a missile strike, but it makes development costly. Scores of missiles often are expended before development problems are solved.

Vought's *Regulus I* and *II* reduce this expense by their dual application. Tactical versions of these guided missiles can strike head-on, with a devastating nuclear wallop. Test and training versions, used in development, can be recovered to fly again.

One *Regulus* was flown and recovered *18 times*... another made 16 successful flights. Six hundred recoveries of both missiles have saved $102,950,000 and gained an inestimable quantity of technical data.

Regulus I has armed submarines, cruisers and carriers with a nuclear punch since 1955. *Regulus II*, with a range of more than 1,000 miles and able to exceed twice the speed of sound, soon will join the Navy's underwater and surface Nuclear Fleet.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. T-3.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

MECHANICAL ENGINEERS

$ds^2 = dx^2 + dy^2 + dz^2 - c^2dt^2$

Is today the same as yesterday?

Every now and then a man stops and takes stock of himself and his career. He sizes up what he has accomplished. Where he is heading.

If you are doing just that and find that you are ready for a long step forward—for increased responsibility and stature—it may pay you to consider Melpar.

These forces will be working for your advancement when you join our organization: an atmosphere of professionalism and regard for your individual ideas and contributions; a promotion policy based *solely* on your ability; a steady program of expansion which continually creates new positions. Challenging assignments are available in packaging of electronic equipment, mechanisms design, heat transfer, and thermodynamics.

Our well equipped laboratories and manufacturing facilities are located near suburbs that promise gracious living for your family and easy commuting for you.

For details about career opportunities at Melpar, write:

Technical Personnel Representative

MELPAR *Incorporated*

A Subsidiary of Westinghouse Air Brake Company

3085 Arlington Boulevard, Falls Church, Virginia

10 miles from Washington, D. C.

Openings are also available at our laboratories in Boston and Watertown, Massachusetts

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Bulk Storage System

The Permaglas storage unit, described as a unique mechanized bottom unloading bulk storage system, has been announced by the A. O. Smith Corp.

The unit is a glass coated, inside and out, cylindrical storage bin. Installed from preformed panels on the site, it is produced in sizes ranging from 14 to 20 ft diam, with heights from 10 to 50 ft, in 5 ft increments. Special formulated glass coatings protect the exterior and interior plate steel panels which make up into the unit. Said to be adaptable to the most limited of space situations, the units are constructed for the most part on a concrete base. This concrete base contains a trough into which the mechanical unloader fits. This mechanized unloader rotates from a center post which sweeps in a full circle cutting a swathe completely about the bin bottom. A chained claw mechanism constantly in operation along the unloader arm, drags material toward the center chute as the arm circles. Materials free fall to trough and are swept by chain and clasp conveyor system that feed into the system, or to discharge, depending upon plant needs.

—K-31

Capacitor Grade Tantalum

Capacitor grade tantalum metal is being introduced as the latest product development of Kennametal Inc.

Bars, sheets, foil, and wire made from tantalum of 99.9 per cent purity are available in production volume. In addition to these forms, tantalum metal granules, of the same high purity, will also be made available.

According to the company, tantalum of such high purity is being utilized extensively in the manufacture of capacitors required with transistors which are being widely used in radio, television, aircraft, missile, radar, fire control, navigational and other equipment. Behind the adoption of transistors are many advantages including compactness and a reduction in weight over equipment previously used.

The firm says high purity tantalum metal has an exceptionally high resistance to some of the most violent corrosive acids and vapors. This characteristic of the metal is said to promise wide adoption in equipment for processing chemicals, pharmaceuticals, and foods where freedom from product contamination and harmful reactions are essential.

—K-32

Settling Tanks

An improved settling tank design, the Uniflow settling tank, for removal of solids from water, sewage, and industrial wastes, has been announced by Link-Belt Co.

The tank is described in detail in a new Folder 2648 that is now being distributed by the company. The text describes advantages of the improved design in attaining: uniform influent distribution across the tank; uniform flow throughout entire tank length; and, uniform effluent discharge from surface.

—K-33

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Jet, Missile Alloys

Allegheny Ludlum Steel Corp. announces development of two new high temperature alloys for use in the jet and missile age.

Designated D-979 and AF-71, these alloys have been produced in billets, bars, sheet, wire, and forgings. Both alloys are now available in experimental quantities on a developmental basis. Commercial size heats up to 20,000 lb have been made under the company's research program.

Both alloys are for jet aircraft engine and gas turbine applications, including compressor parts, turbine buckets, wheels, spacer rings and casings, and fasteners, the firm states. Other probable uses will include rocket and ram jet engine components, automotive gas turbine blades and wheels, stationary gas turbine buckets and wheels, and steam turbine and steam plant components including buckets, fasteners, and piping, and possibly missile and supersonic airframe parts.

Alloy D-979 is a nickel-chromium based material produced by the consumable electrode vacuum melting process. Designed for applications requiring high strength at temperatures up to 1600 F, it is said to offer superior tensile and creep rupture properties.

Alloy AF-71, developed under contract with the U. S. Air Force, is a comparatively inexpensive high temperature, high strength alloy with outstanding creep-rupture properties in the 1000 to 1500 F range. It is an iron-chromium-manganese material with low strategic alloy content, but which is almost as strong at 1500 F as other superalloys containing 40 to 50 per cent cobalt. —K-34

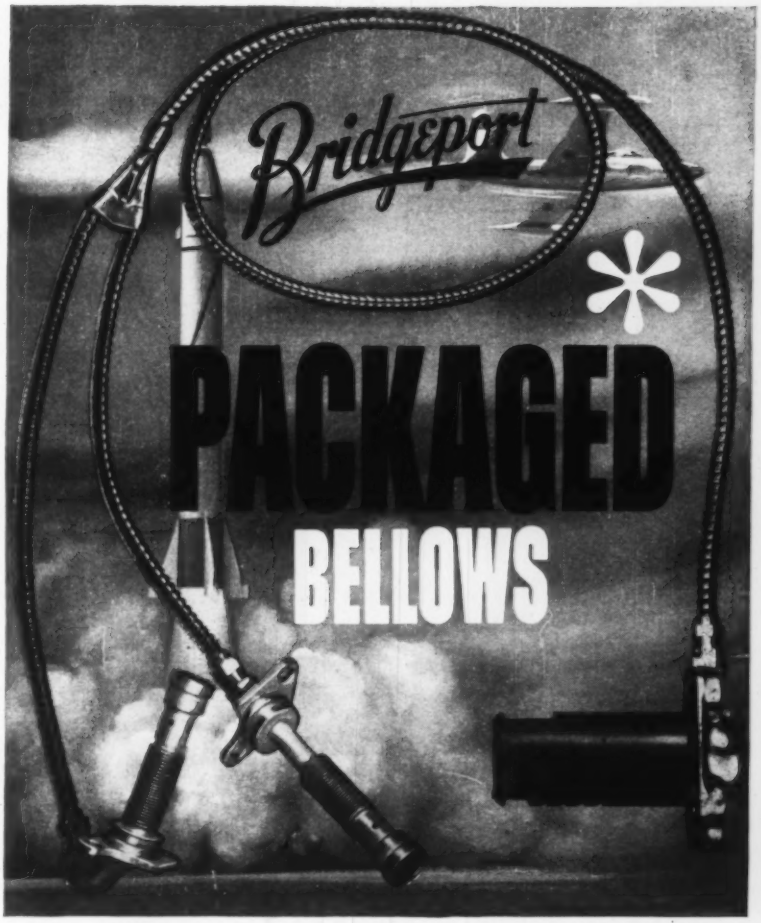
Elastomeric Adhesive

A new elastomeric base adhesive said to provide exceptionally high strength bonds between a variety of laminating materials without the need of heat or pressure is now available from Adhesives, Coatings & Sealers Div., Minnesota Mining & Mfg. Co.

Designated as EC-1368, the light colored adhesive produces high strength laminates with plastic, steel, aluminum, wood, and other materials, the firm states. It says it can be used in industrial operations, such as those of bonding decorative plastic laminates to metal counter and table tops. This adhesive can also be used for nonload-bearing sandwich panel construction in which plastic, steel, or aluminum facings are bonded to paper honeycomb cores.

A variety of plastic coated fabrics can also be bonded to rigid sub-surfaces including steel, aluminum, and wood with this adhesive, it is stated.

Bonds produced by the adhesive have exceptionally high dead load shear strength, high peel strength, and excellent resistance to cold flow, the company reports. This adhesive also is said to have exceptionally good water resistance and will retain strength and adhesion at temperatures over 200 F. —K-35



SAVE by specifying custom-engineered bellows and all accessories from one source

The complete "package" (*seamless metal bellows and all assembly components) costs less, performs better when designed as an integral unit . . . produced to one high standard of quality . . . tested under uniform procedures . . . and delivered already assembled.

You cut handling, assembling, testing, incoming inspections and paper work in your plant. What's more, custom-engineered Bridgeport Packaged Bellows mean lowest possible unit cost and only one manufacturing responsibility.

Wide selection of bellows metals, plus choice of multiple plies, permits outstanding stability under tough conditions of temperature, pressure, corrosion and vibration. Bellows sizes from subminiature ¼" O.D. up to several inches O.D.

Ask your Bridgeport sales engineer about Packaged Bellows for general industry and airborne applications . . . or write for Bulletin D-106

Mr Controls
Robertshaw-Fulton
CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • Milford, Conn.

FOR BIG POWER use Maxi-Power

PARALLEL SHAFT HELICAL GEAR DRIVES

1. Heavy duty, reinforced design housing for permanent alignment, rigid shaft support.
2. One mesh per reduction—fewer moving parts.
3. Broad faced helical gearing—high quality, accurately hobbed for greater strength, durability. Uniform tooth deflection under load . . . no uneven wear.
4. Shafts firmly held in place. Positive gear location assures full tooth engagement across entire face.
5. Smooth, overlapping mesh, close backlash tolerances, no oil trap, provide quiet operation, less heat generation.
6. Heavy duty, anti-friction bearings. Conservatively rated for wide range of operation.

Capacities to 1550 H.P.

★ Single, Double, Triple Reductions

★ Standard Ratios from 2.08 to 1 up to 360 to 1

★ 9 Shaft Arrangements

There's more capacity, greater stamina and longer service life built into Foote Bros. Maxi-Power Parallel Shaft Drives. Simple, balanced design, fewer moving parts, heavy duty construction, efficient lubrication and conservative ratings make Maxi-Power drives the logical choice for critical applications and severest operating conditions.

You can depend on Maxi-Power Drives to produce maximum performance with minimum attention because they're built for just that kind of service.

Write for Engineering Manual MPB—has complete details and selection data. There's no obligation.

this trademark stands for the finest industrial gearing made

FOOTE BROS. Quti-Rated LIFETIME GEARING

T. M. REG. U. S. PAT. OFF.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION

4559 South Western Boulevard Chicago 9, Illinois

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Electro-Magnetic Brake

Stearns Electric Corp. announces the design of a new style DM electro-magnetic disc brake incorporating torque ranges from 30 lb ft to 7500 lb ft.

The brake is spring set, magnetically released for fail safe application. It is designed for higher thermal capacity jobs, utilizing special carrier rings to hold the friction linings. It is for d-c operation and is arranged for foot mounting for easier adaptation into many types of equipment. **—K-36**

High-Vacuum Pump

A high-vacuum pump said to provide three times better ion pumping speed and greater dependability has been announced by Rochester Div., Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.

Named the Evapor-ion pump, Type EI-2000A, it provides an electronic method for producing high vacuum without the use of organic pump fluids. The pump is the only device available that creates a dry vacuum in the range from 10^{-4} to 10^{-8} mm Hg, the company claims. It pumps active gases by the gettering action of evaporated titanium wire, and pumps inert gases by ionizing and burying them under a layer of titanium.

Continuous titanium wire evaporation is said to be assured by an improved feeder mechanism. Operation is possible for periods up to six months or longer without breaking for vacuum for pump servicing, the firm states. A power supply cabinet provides three times the accelerator grid current formerly possible and permits easier starting of the pump by simultaneous power application to the electrodes and firing of the primers used for roughing out. These primer charges have a combined absorption capacity of 360,000 micron-l of active gases.

The pump has a pumping speed of 1900 l per sec for nitrogen, 1000 l per sec for oxygen, and 3000 l per sec for hydrogen. It also pumps other gases, including water vapor, at high speed, the company says. Refrigerated traps or baffles are not required, and mechanical forepressure pumping for continuous operation is not needed. **—K-37**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Capacitor Motors

A line of heavy-duty capacitor-start induction-run single phase integral horsepower motors designed to provide high starting torque and operating efficiency has been announced by Fairbanks, Morse & Co.

The firm says that for starting, the new motors use top-quality capacitors of the dry electrolytic type designed for maximum starting torque with minimum current usage. When the motor gains speed, a centrifugal switch cuts out the capacitors for straight induction run. The switch is of unusual design with over-size snap action contacts. They are said to be easy to reach through the access cover and can be replaced without disturbing the centrifugal actuating mechanism or any other part of the motor.

The Type WCZK single-phase 60-cycle, 115/230 volt motors are available from $^3/_4$ to $1^1/_2$ hp at 1200 rpm, 1 to 3 hp at 1800 rpm, and $1^1/_2$ to 5 hp at 3600 rpm.

The motors are described as being of particularly sturdy construction with entirely new drip-proof frames which are in full compliance with the the latest NEMA standards and dimensions. These frames are of corrosion-resistant cast iron. Solid upper-half bearing arm access covers ward off falling dirt or water without interference to the ample flow of ventilating air which assures a cool running motor, free from hot spots, it is claimed. —K-38

Ball-Bearing Clutches

Formsprag Co. announces the addition of 10 new clutches to its lines of ball-bearing clutches for overrunning, indexing, and backstopping applications, and a completely new line of sleeve-bearing large-bore backstop clutches. According to the firm, the new ball-bearing clutches have the highest torque capacity in relation to bore size of any overrunning clutches currently available. They include three high-speed ball-bearing clutches, Series A: FSA-800-108 with a maximum bore diameter of 4 in.; FSA-900-49, with a maximum bore diameter of 5 in.; and FSA-1000-40, with a maximum bore diameter of 6 in.

In both Series B and Series C of sealed ball-bearing clutches there are also three new sizes: FSB-800-108 and FSC-800-108, each with a maximum bore diameter of 4 in.; FSB-900-49 and FSC-900-49, with a maximum bore diameter of 5 in.; and FSB-1000-40 and FSC-1000-40, with a maximum bore diameter of 6 in.

The sealed ball-bearing clutches are designed especially for use under exceptionally dirty operating conditions and in atmospheres contaminated by abrasives. Series B clutches, which are oil-lubricated, are intended for indexing operations; while Series C clutches, which are grease-lubricated, are recommended for backstopping purposes. —K-39

Recent WILEY Books

1. AUTOMATIC PROCESS CONTROL

By DONALD P. ECKMAN, Case Institute of Technology.

Treats important principles of automatic control, emphasizing block diagrams and frequency techniques in process control. 1958. 368 pages. $9.00

2. AIRCRAFT AND MISSILE PROPULSION Volume I: Thermodynamics of Fluid Flow and Application to Propulsion Engines

By M. J. ZUCROW, Purdue University.

The first of a three-volume work designed to give a better understanding of the fundamental principles governing the functioning and operating characteristics of engines used to propel winged aircraft and missiles, both guided and unguided, at high speeds. 1958. 538 pages. Illus. $11.50.

3. MECHANICAL VIBRATIONS

By A. H. CHURCH, New York University

The basic principles of vibration analysis, with emphasis on their practical applications. Coverage includes: forced vibration of multi-mass systems; harmonic analysis; torsional critical speeds; electrical analogies; coupling action; balancing of angle or vee engines. 1957. 275 pages. 186 illus. $6.75.

4. AIR CONDITIONING AND REFRIGERATION

By the late WILLIAM H. SEVERNS, and JULIAN R. FELLOWS, both of the University of Illinois.

Based on the 2nd Edition of *Heating, Ventilating and Air Conditioning*. Has an expanded treatment of refrigeration, a chapter on fluid flow, and a discussion of air washer design. Covers thermodynamics, fluid mechanics, combustion, and fuel selection. 1958. 564 pages. $10.25

5. THE METALLURGY OF VANADIUM

By WILLIAM ROSTOKER, Armour Research Foundation

An up-to-date progress report providing a comprehensive treatment of its extraction, properties, and processing. One of the Wiley Series on the Science and Technology of Materials: J. H. Hollomon, Advisory Editor. 1958. 185 pages. $8.50

6. ELEMENTS OF HEAT TRANSFER—3rd Edition

By the late MAX JAKOB, and GEORGE A. HAWKINS Purdue University

Stresses basic principles and their applications. Discusses more difficult methods, details and procedures, and contains added material. 1957. 317 pages. Illus. $6.75

7. INSTALLING ELECTRONIC DATA PROCESSING SYSTEMS

By RICHARD G. CANNING, University of California, Los Angeles

Tells how to organize the EDP section, select personnel, number and type of people needed, total cost, etc. 1957. 193 pages. Illus. $6.00

8. MOTION AND TIME STUDY—4th Edition

By RALPH M. BARNES, University of California, Los Angeles

Contains new material on: developments in the industrial use of pulse rate as an index of physical activity; statistical procedures in time study; auditing of methods, time standards, and wage incentive plans. 1958. 665 pages. Illus. $9.25

9. IDEAS, INVENTIONS, AND PATENTS How to Develop and Protect Them

By ROBERT A. BUCKLES, New York Bar

What to do when you get an idea for an invention—how to assure yourself of maximum protection—how to avoid costly mistakes. 1957. 270 pages. Illus. $5.95

10. THE SPECTROSCOPY OF FLAMES

By A. G. GAYDON, Warren Research Fellow of the Royal Society

Important new experimental techniques for controlling flames and for exciting flame-type spectra. 1957. 280 pages. Illus. $9.00

11. TECHNICAL REPORT WRITING

By JAMES W. SOUTHER, University of Washington

A practical presentation of the basic essentials. 1957. 70 pages. $2.95

Mail this coupon for ON-APPROVAL copies!

ME-68

JOHN WILEY & SONS, Inc.
440 Fourth Ave., New York 16 N. Y.

Please send me a copy of the book(s) circled below to read and examine ON APPROVAL. Within 10 days I will return the book(s) and owe nothing, or I will remit the full purchase price(s), plus postage.

1 2 3 4 5 6 7 8 9 10 11

Name.....

Address.....

City..... Zone..... State.....

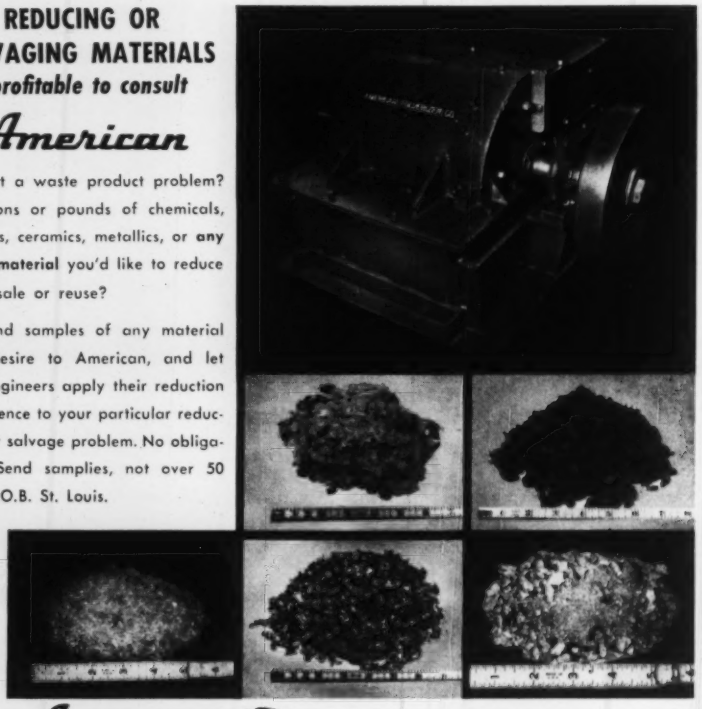
☐ SAVE POSTAGE! Check here if you ENCLOSE payment, in which case we pay postage. Same return privilege, of course.

FOR REDUCING OR SALVAGING MATERIALS
it's profitable to consult

American

Got a waste product problem? Got tons or pounds of chemicals, plastics, ceramics, metallics, or **any other material** you'd like to reduce for resale or reuse?

Send samples of any material you desire to American, and let our engineers apply their reduction experience to your particular reduction or salvage problem. No obligation. Send samples, not over 50 lbs., F.O.B. St. Louis.



American **PULVERIZER COMPANY**
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1541 MACKLIND AVE. SAINT LOUIS 10, MO.

Have You Reserved Your 1959 MECHANICAL CATALOG?

Every year, more than 15,000 Mechanical Engineers ask for and receive their copy of MECHANICAL CATALOG. They find it an indispensable aid in filling design specifications and in locating sources of supply for thousands of different items.

It is the only directory of its kind in industry . . .
yet it is made available at no cost by the ASME to any member who needs it.

The 1959 Edition of MECHANICAL CATALOG is now in preparation . . . more complete than ever. Your questionnaire has been mailed to you. Please sign and return it promptly to us. Your personal copy will be sent to you as soon as it has been printed.

Mechanical Catalog
American Society of Mechanical Engineers
29 West 39th Street
New York 18, N. Y.

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Flow Control Valve

A new flow control valve for 2000 psi, which is said to be unaffected by changes in temperatures and viscosity, is announced by Denison Engineering Div., American Brake Shoe Co. It is designed in $^1/_4$, $^3/_8$, and $^3/_4$ in. sizes.

According to the company, the valve is constructed on the principle that the rate of fluid flow through an orifice that connects two bodies of fluid will remain constant when the pressure differential between the two bodies of fluid remains constant.

The valve has a fluid pressure compensator, responsive to both inlet and outlet, designed to create a body of fluid upstream of the orifice to maintain a constant pressure differential with the pressure in the outlet port. It also has an adjustable orifice between the differential pressure area and the outlet port.

The adjustable orifice feature provides full regulation of flow within both a given range and multiple ranges in each valve size, the firm states. The orifice is adjustable in length and width.

A removable pin and an index plate determines and limits each range of control. To change the range, a finger-tight locknut, control knob and pin are removed and an index plate turned until the desired range number lines up with the dowel pin hole in the body. With the control knob installed and the locknut finger-tight, the control spool may be rotated until the desired rate of flow is reached, the company states. Should pump delivery be varied, or a different pump introduced into the circuit, the orifice may be adjusted to control a different volume and still provide full scale adjustment. **—K-40**

Electric Fuel Pump

An electric fuel pump, said to be capable of delivering more gallons of gasoline per hour than required by the largest of today's truck or bus engines as they operate at full speed, and featuring a built-in automatic pressure regulator adjustable to the specifications of the carburetor manufacturers, has been announced by Instrument Div. Stewart-Warner Corp.

The new pump, Model 240-A, is capable of pressures of more than 8 psi, but can be adjusted to any desired level. An oversize piston, coil and power spring make delivery of up to 60 gal of gasoline per hour possible, it is reported.

The regulator prevents the pump from putting forth higher pressures than the predetermined setting and, at the same time, it permits the pump to operate at its full power in delivering fuel. The regulator also acts as a surge chamber and evens out the flow of gasoline to the carburetor, the firm explains.

The new pump works independently of the engine and starts to work the instant the ignition switch is turned on. It fills the curburetor float bowl before the starter turns the engine over. **—K-41**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Shock Machine

Simulated shocks with wave forms that are closely controllable and exactly repeatable are generated by a new shock machine for shock testing of small size equipment for missiles and aircraft, developed by Barry Controls Inc.

The unit is designed for shock testing of components and assemblies weighing up to 60 lb. It is said to be completely integral, occupying only 22 × 39 in. of floor space, and portable.

The new Type 15575 shock machine produces a defined shock pulse whose wave shape, magnitude, and time duration can be accurately repeated. It will generate the 100g shock test defined by the Ramo Woolridge Missile Test Specification, as well as tests called out by MIL specifications.

Utilizing the vertical-drop design, the unit requires no auxiliary reservoir of power, impact on various materials of different configuration generate the desired wave shapes. Half-sine waves are produced by elastic impact upon rubber compression pads, saw tooth pulses from dropping upon conical lead pellets, or semi-square pulses by a punch impacting into a lead bar.

The range of shock pulses provided is from 2 milliseconds at up to 700g peak acceleration to 60 milliseconds at up to 25g peak acceleration. —K–42

Synchronous Generator

Redesign of its high-speed synchronous generators in single bearing units for internal combustion engines, close-coupled to standard SAE flanges, or in two-bearing units for belt drives or direct connection has been announced by Allis-Chalmers.

Available in ratings from 30 through 150 kw at 1800 rpm and 50 through 300 kw at 1200 rpm, the generators feature an improved exciter located inboard of the bearing which is designed to provide a shorter, lighter, more compact machine.

The generators are equipped with oversize grease-lubricated ball bearings, said to eliminate the need for oil filters and sight gages. A rigid rolled steel yoke and cast iron housings provide a solid bearing support for extended bearing life and protection against mechanical damage, the company reports.

Other features of the generators include field poles dovetailed to the shaft, damper windings die cast in the face of the rotating field pole to assure good generator paralleling characteristics, and easily accessible brush holders.

The generators meet NEMA, AIEE and ASA standards. Units are also available to meet ABS and AIEE, Section 45, as well as Marine and Lloyds of London specifications. —K–43

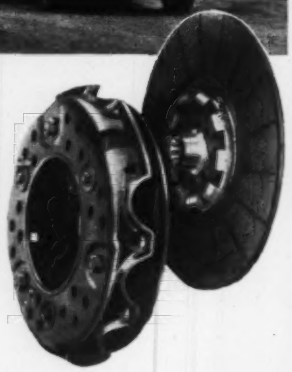
Diaphragm Pump

A heavy duty, all-purpose, positive displacement, diaphragm pump designed for the safe and dependable feeding of a wide variety of corrosive fluids is described in a bulletin now available from Proportioneers, Inc., Div. of B-I-F Industries, Inc.

Known as the Model 47 Chem-O-Feeder, the packaged pump is available in three models having 1, 2, or 3 feeding heads, each independently adjustable, for application versatility. The bulletin contains photographs, tables, performance curves and typical installation diagrams. —K–44

BIG
The BIG year for BIG performance
GENERAL PURPOSE
FANS
From design through maintenance, present day air handling problems demand BIG performance from fans. And General Purpose Fans do the job, give you that BIG performance. They're made in four types, 12 basic sizes, with capacities from 160 to 19,070 Cfm; in both constant speed units with direct connected motors and adjustable speed units with V-belt drives and integral mounted motors. Send for Bulletin 563.
...self-contained
portable units for process and ventilating applications...
nyb
THE NEW YORK BLOWER COMPANY
Sales offices: 3161 South Shields Avenue • Chicago 16

ROCKFORD



CLUTCHES
Are Adapted for Use with High-Speed Engines

Because modern construction methods require faster and faster delivery hauls with more and more cycles per hour, high speed engines are a must. The centrifugal force they develop presented a clutch problem—until ROCKFORD CLUTCHES were designed to minimize the effect of their multiplied degree of centrifugal force. If you want your heavy-duty machines to stay more hours ON THE JOB with less time IN THE SHOP—for adjustments and repairs—it will pay you to investigate the more torque grip, longer work life, and better heat disposal provided by ROCKFORD CLUTCHES.

SEND FOR THIS HANDY BULLETIN
Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

Small Spring Loaded

Automotive Spring Loaded

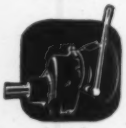
Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs


Speed Reducers

ROCKFORD B-W BORG-WARNER

ROCKFORD Clutch Division BORG-WARNER
1307 Eighteenth Ave., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Aluminum Tubular Shapes

Aluminum Co. of America has announced that it has perfected and amplified what it describes as a revolutionary process for producing tubular shapes within sheet and plate.

The product of the new manufacturing method has been identified by the firm as expandable tube-sheet. It is a unique, one-piece unit of aluminum sheet, or plate, containing series of lengthwise, parallel areas that can be expanded easily to form integral tubing. —K-45

Forged Steel Valves

A line of forged steel gate valves, designed and built for installation in cramped quarters, is being introduced by Lunkenheimer Co.

Featuring the bolted bonnet design, with outside-screw rising stem, solid-wedge disk, and rolled-in seat rings, the valves are available with screwed or socket welding ends in sizes $\frac{1}{2}$ through 2 in. They are rated 800 lb at 850 F, and 2000 lb at 100 F.

The solid-wedge disk is machined and guided to a firm, tight seat without dragging across the seat rings, the firm reports. Both the disk and seat rings are hardened all the way through to eliminate chipping or cracking of seating faces. Disks are 13 chrome stainless steel, hardened to 500 Brinell.

A two-piece gland with ball and socket joint is designed to prevent binding due to uneven pull-up of eyebolts. The gland follower of stainless steel resists corrosion and prevents scoring of the stem. —K-46

Acid-Regeneration System

Graver Water Conditioning Co. has available a progressive acid-regeneration system said to automatically increase acid regenerant concentration to the cation units of their demineralizers at prescribed rates in an infinite number of steps.

This system is desirable when full optimum cation-exchange performance characteristics and reproducible results with minimum operation supervision are desired, the firm states.

Normally, the company explains, cation exchange resins are regenerated with sulfuric acid of specific concentrations. However, on certain water supplies there is the danger of forming inhibited calcium sulfate precipitates during regeneration and special precautions must be taken. One of these methods of regeneration is the firm's step-rinse "Gradient" or "ascending" acid regeneration system that is said to increase the prescribed rates in an infinite number of steps.

The major controls for this automatic progressive system consist of a transiter to measure the acid flow, a control valve to control the flow, a flow controller to control the valve and a program regulator cam to operate the variation of flow. —K-47

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Momentary Valve Adaptor

Ross Operating Valve Co. announces a single momentary double stroke adaptor designed to convert any of its Skyline series valves to momentary action.

According to the company, the adaptor can be inserted between any of this series' head and body combination. Used in a single solenoid valve, the valve reverses and stays put each time the solenoid is energized. Used with an air operated valve, the valve reverses and stays put with each pilot air impulse, the firm reports. —K–48

Automated Welding Line

A new, huge L shaped automated welding line that produces 500 complete automotive floor pan assemblies per hour has been designed and built by the Welding and Automation Machine Div., Expert Die and Tool Co., Inc.

The new unit consists of two separate lines which intersect each other to form an L shaped floor layout. One line, called the ladder line, consists of six stations designed to fabricate completely the floor pan reinforcing member with 48 resistance welding operations.

The other line, called the main line, consists of six working stations and welds the reinforcing member to the floor pan with 320 spot welding operations. The main line portion of the automated welding line also features unique automatic loading and unloading operations.

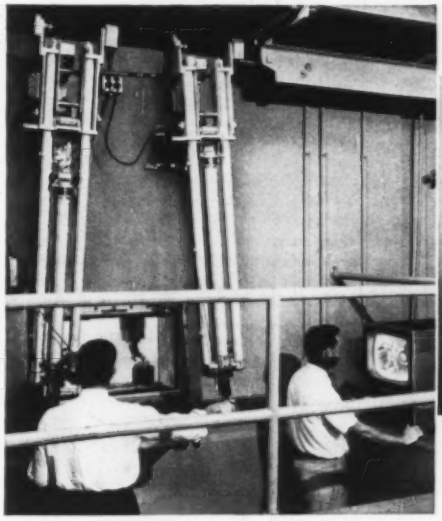
The company explains that to begin automatic fabrication operations of the reinforcement member, two seat guide reinforcements and No. 1 and No. 2 cross members are manually loaded in preload station one of the latter line. These components are then transferred to station two where two C frame-type opposed resistance welders spot weld the components together. These welded components are then transferred to another preload station (station-three) where the No. 3 cross member is manually loaded on the station fixture. The assembly is then transferred to station four where side sills are loaded on the station fixture. Also in station four, the side sills and the No. 3 cross member are spot welded to the assembly by a table top welder. This welded assembly is then transferred through idle station five to station six. In station six, body bolt brackets are manually loaded on the station fixtures and welded to the side sills and No. 1 cross member. The No. 2 and No. 3 cross members are also finish welded to the side sills in station six.

The transfer of the reinforcement components during fabrication is accomplished by a lift-and-carry type shuttle mechanism, hydraulically powered and operated by a 3 to 1 rack and pinion gear arrangement. Deceleration valves are used to provide rapid shock-free indexing of the shuttle. —K–49

Diamond

"UtiliVue"
(WIRED TELEVISION)

IMPROVES HANDLING
of RADIOACTIVE MATERIAL



Mechanical manipulators are watched, close-up and from the side, by Diamond "UtiliVue". Personnel are fully protected from radiation.

Diamond "UtiliVue" camera mounted in radioactive cell has remote focus and three-position remote control lens turret.

AT NUCLEAR SYSTEMS
a division of the Budd Company
Philadelphia, Pa.

This is one of many installations where a Diamond "UtiliVue" permits close watch of operations with complete safety to personnel. The Diamond ITV Camera here is an invaluable ally to the viewing window as the mechanical manipulators handle radioactive material. It provides important depth perception and permits a close-up view for fine detail.

You may never handle radioactive material, but Diamond ITV can save you money and improve a wide variety of operations. Investigate today. For further information, use the coupon below.

Diamond
DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO
OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited — Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment for Industry

7895A

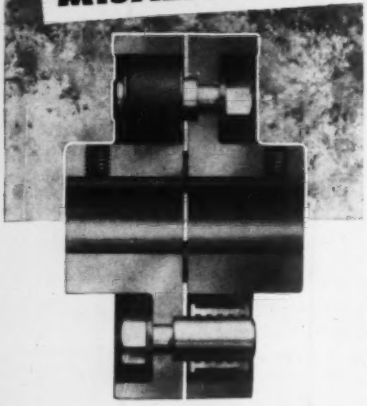
DIAMOND POWER SPECIALTY CORP.
ELECTRONICS DEPT., P.O. BOX 58V
LANCASTER, OHIO

Please send me without obligation a copy of bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs and improve operations.

Name_____
Title_____
Company_____
Address_____

Rx AJAX

FLEXIBLE COUPLINGS CURE YOUR BREAKDOWNS DUE TO MISALIGNMENT

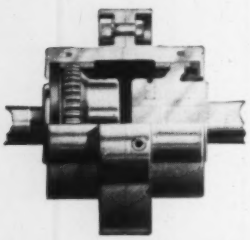


Usually you don't detect misalignment strains until something lets go. That's why it is good preventive practice to specify Ajax Flexible Couplings on new equipment and also install them on your present direct-connected machines. You save wear on bearings, gears, impellers, armatures, and housings.

A shut down machine can shut down a department, and that can cost a thousand times more than an AJAX Flexible Coupling.

Complete lines of AJAX bronze bushed, rubber-cushioned and Dihedral gear couplings... angular and/or offset capacity up to 7 degrees... competitive prices.

Write for catalog



AJAX

FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Vaneaxial Blowers

A new line of small, compact vaneaxial air moving units for electronic equipment cooling and other blower applications where space is critical is now available from American-Standard, American Blower Div.

The new fans can be furnished in a variety of housing shapes, sizes, flange designs, finishes, and mounting arrangements, the firm reports. It says all can be designed to meet military specifications. The new line includes both single-stage and two-stage units. All are direct-drive with integral electric motor.

One single-stage blower in the line, for example, is a high efficiency unit designed specifically for cooling electronic equipment and inflating military radomes. Rated at $^7/_8$ hp at 5600 rpm, the 11-in. × 11$^3/_4$ in. package delivers 700 cfm of air at 4.0 w.g. static pressure.

Typical of two-stage units in the line is a compact 2$^1/_4$-hp blower designed for high pressure, low volume performance suitable for cooling Magnatron tubes in radar sets. It measures 11$^1/_2$ in. long by 14$^1/_4$ in. diam and can deliver 400 cfm at 19.0 in. w.g. static pressure. **—K-50**

High Vacuum Pumps

Arthur F. Smith Co., 311 Alexander St., Rochester 4, N. Y., announces its Asco-Vac 10 series of portable laboratory mechanical high vacuum pumps.

The new pumps feature a high, efficient pumping capacity, clean and quiet operation, gas ballast, and an economy of operation due to a much smaller volume of oil charge, the company says. Free air displacement is 50 l per min, with a guaranteed absolute pressure of 0.1 μ with the 2-stage units and 30 μ with single stage.

According to the firm, noise is eliminated by insulation and rubber mounting, and the vertical design has done away with the conventional belt and pulley. These unique design features permit a carrying handle on the supermount for portability.

The vertical design makes the pumps leakproof, and with the visible oil level cup, spillage by the user is confined to a minimum, the company says, and in filling the pump, oil is not introduced at point of discharge. **—K-51**

PAST EXAMINATIONS

for Professional Engineers given by New York State

This pamphlet contains the questions given in 1952–1956 examinations. They cover problems in structural planning and design, in practical applications of basic engineering sciences, and the more advanced and specialized problems in practical applications of engineering principles and methods.

$2.00 (20% Discount to ASME members)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 W. 39th S., New York 18, N. Y.

VIGILANCE

The final victory over cancer will come from the research laboratory.

But there is a more immediate victory at hand today. Many cancers can be cured when detected early and treated promptly. *Vigilance* is the key to this victory.

There are certain signs which might mean cancer. Vigilance in heeding these danger signals could mean victory over cancer for you:

1. Unusual bleeding or discharge.
2. A lump or thickening in the breast or elsewhere.
3. A sore that does not heal.
4. Change in bowel or bladder habits.
5. Hoarseness or cough.
6. Indigestion or difficulty in swallowing.
7. Change in a wart or mole.

If your signal lasts longer than two weeks, go to your doctor to learn if it means cancer.

AMERICAN CANCER SOCIETY

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Dust Collector

A large dust collector, using 24-in. diam tubes, has been developed by Research-Cottrell, Inc. It was designed to apply the firm's system to collecting abrasive, hygroscopic, and high-moisture content materials.

According to the company, the collector could also provide a more economical installation than smaller units in certain applications where collection efficiencies below 85 per cent satisfy requirements.

The unit has 14 inlet vanes compared with seven in the smaller unit. Both are centrifugal, multiple tube collectors employing the same design features.

The units have aerodynamically shaped inlet vanes of the outlet tube designed to minimize gas turbulence around these vanes and develop higher centrifugal forces. The firm states the positioning of the recovery vanes below the tube allows more of the energy contained in the centrifugal force to be recovered and put to work in the outlet tube. —K-52

Hose Nozzle Valve

Milwaukee Valve Co., a subsidiary of Controls Co. of America, Milwaukee, Wis., announces the development of a new hose nozzle valve, Model P-2050.

The Cushion Close valve, developed for the U. S. Air Force, will protect fuel line hoses against hammer blow effects due to fast closing, the company reports, stating that the soft 1, 2, or 3-second closing action of the new valve will eliminate the damage and danger of bursting fuel lines by cushioning the shock.

The valve requires less than 16 lb lever pressure under full line pressure from 25 to 70 psi. When open the valve works with the line pressure. A two stage fulcrum lever is designed to open with very slight hand pressure. —K-53

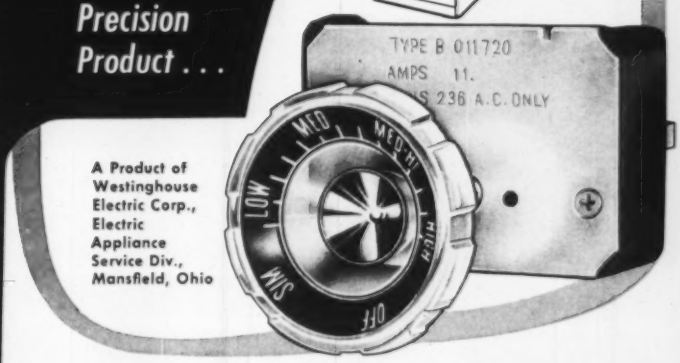
...because they need the money

for DISASTERS · ARMED FORCES
BLOOD BANK · TRAINING PROGRAMS

Chace THERMOSTATIC BIMETAL

Actuates Another Precision Product . . .

THE Westinghouse RANGE CONTROL SWITCH



A Product of Westinghouse Electric Corp., Electric Appliance Service Div., Mansfield, Ohio

No more big "jumps" in electric range surface cooking heats. This Westinghouse Range Control Switch provides an infinite number of heats for all surface burners and is incorporated in the entire 1958 line of ranges. As many as four are used to control the average wattage delivered to each heater. This well-engineered and precision-manufactured product uses three thermostatic bimetal elements: the main operating element to open and close contacts; the differential element to introduce some temperature differential and thereby prevent contact fluttering; and the compensator element to give identical per cent inputs at all ambient temperatures.

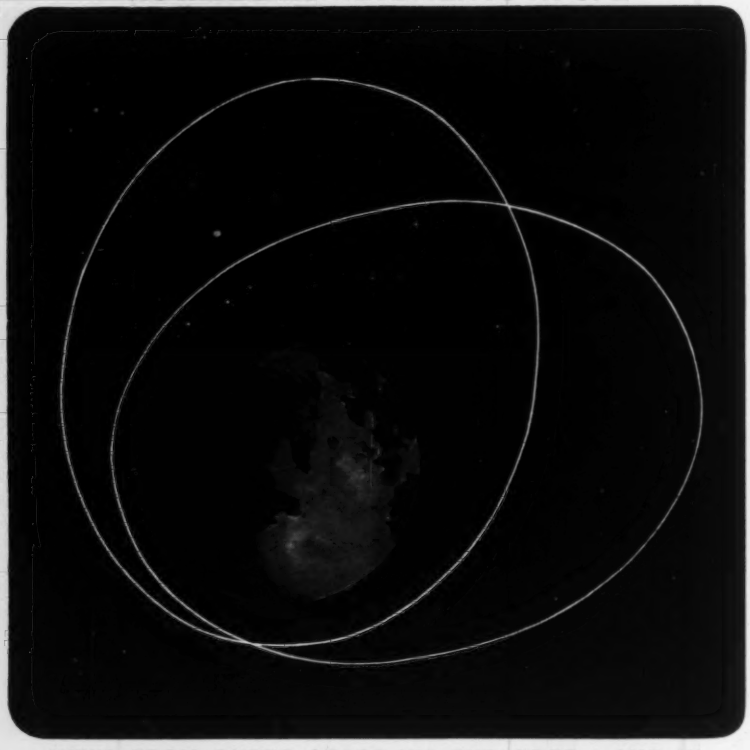
We at Chace accept the heavy responsibility placed upon us by appliance manufacturers such as Westinghouse. For it is our duty—and our privilege—to provide dependable thermostatic bimetal for the countless actuating devices in the millions of appliances which help to make our lives safe, comfortable and worry-free. Thus these marvelous products can go to the far corners of the globe—and the automatic features actuated by Chace Thermostatic Bimetal will operate year after year with efficiency and a minimum of attention. In more than a third of a century as exclusive manufacturers of bimetal, we have learned that only a truly precision product can give completely reliable service.

So remember Chace when you design for protection of valuable equipment or for temperature actuation or indication. Dependable Chace Thermostatic Bimetal is available in over 30 types, in strip, coil or completely fabricated and assembled elements to your design. Write today for new 1958 booklet, "Successful Applications of Chace Thermostatic Bimetal", containing many pages of design data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

NOTABLE ACHIEVEMENTS AT JPL



NEWS FROM OUTER SPACE VIA EXPLORER I AND III

Since the successful launchings of the Explorer I and III Satellites under the joint cooperation of the Army Ballistic Missile Agency and JPL, literally, bales of information on conditions outside the earth's atmosphere have been transmitted earthward from both satellites.

This information on cosmic ray activity, micro-meteorite density, and radiative heat flux is providing valuable new and accurate data of immense value to scientific research. Explorer III with its more sophisticated instrumentation is producing more complete data than Explorer I. This is partly due to the wider range of altitudes traversed by the orbit of Explorer III, but principally due to the presence in Explorer III of a tape recorder. Designed by Dr. Van Allen of the State University of Iowa it is no larger than a cigarette package and is capable of transmitting two hours of collected cosmic ray information in a space of five seconds.

The Laboratory is proud to have been chosen by the U. S. Army to spearhead this vital activity and to acknowledge the highly constructive efforts of many individuals and organizations who have cooperated with its own staff.

CAREER OPPORTUNITIES NOW OPEN IN THESE FIELDS

ELECTRONIC, MECHANICAL, CHEMICAL, AERONAUTICAL ENGINEERING • PHYSICS AND MATHEMATICS

U.S. Citizenship Required

jpl

JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA • CALIFORNIA

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Air-Cooled Industrial Engines

Hercules Motors Corp. will take over the manufacture of two Lycoming air-cooled industrial engines, now being made by Lycoming Div., Avco Mfg. Corp., Williamsport, Pa.

The firm said it had acquired the tools, dies, patterns, inventory, and know-how and hoped to start production of engines in Canton, Ohio, about March 1. The cash consideration was not disclosed. Lycoming, which has manufactured more than 60,000 air-cooled reciprocating engines for the nation's aircraft industry during the past two decades, will continue to cooperate with Hercules for an extended period. **—K-54**

Electronic Inspection

A new automated electronic inspection machine that checks concentricity as well as three other size dimensions on either in-process or finished engine valves is available from Arlin Products, Inc., 13541 Auburn Ave., Detroit 23, Mich.

The model automatically checks concentricity of the valve seat and stem, valve stem straightness, head thickness and overall valve length at a production rate of over 3000 pieces per hour, the company states. The seat and stem concentricity check is independent of the size of the valve.

The machine is controlled by an electronic cybernetic system. This electronic system receives signals from the compact inspection gage heads regarding concentricity, straightness, thickness and length and stores this information and relates it to solenoid controlled gates in segregation chutes. After inspection, the valve is then directed to the proper rejection or pass chute.

Gage heads are used to check valve dimensions. These operate on a radar-type reflected wave circuit using a frequency of 30,000,000 cycles per second. They can operate to 0.000001-in. constantly with 100 per cent repeatability and no wear even after years of service, the company claims. The electronic circuit is of plug-in design. The circuit is divided into packaged units which may be removed for inspection or replacement.

Valves are fed to the machine from a standard $8\frac{1}{2}$-cu ft hopper. The hopper is equipped with an elevator and horizontal conveyor, each having separate motors and gear reducers, and cybernetic and electronic controls which feed the valves at a continuous orientated flow at the required speed.

Because of the accurate incrementation of the electronic inspection set-up controls, a master valve is not required to set up the concentricity check, the company says. Only the approximate size of the valve is needed to permit setting up concentricity limits on the gage. Also, only a valve of known size and one that falls within the limits of the inspection dial is needed to set up the other inspection stations. **—K-55**

Need more engineering information on products featured in this issue?

USE THE POSTAGE-FREE CARDS . . .

If you would enjoy receiving additional engineering information on any of the products

advertised in this issue or
detailed in the Keep Informed Section

. . . . . circle the page numbers of these advertisements or items on one of the cards below . . . . . fill in your name and mail to us. Your requests will be promptly forwarded. All information will be directed to you.

(Note: Students please write direct to manufacturer.)

When more than one advertisement appears on a page, the following code identifies the location of the ad on page: T-top, B-bottom, L-left, R-right, IFC-inside front cover, IBC-inside back cover, OBC-outside back cover.

MECHANICAL ENGINEERING—JUNE 1958—**Products Advertised**

IFC	18,19	31	43	155	176T	190L	197	211,212	229R	IBC
1	20	32	44	157	177	190R	199	213	230L	OBC
2	21	33	45	159	178	191	200	215	230TR	
4	22	34	46,47	160	179	192L	201,202	217	231L	
6	23	35	48	163	180L	192R	203	218	231TR	
7	24,25	36	49	164	181	193L	205	219	231BR	
8,9	26	37,38	50	165	185	193R	206	222	232	
12,13	27	39	51	166,167	187	194	207	223	239	
14,15	28	40	52	173	188L	195	208	226	241	
16	29	41	53	174	188TR	196L	209	227	243	
17	30	42	54	175	189	196R	210	229L	244	

PLEASE SEND me more complete engineering information on the products advertised in the pages circled above.

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

CITY and STATE.....

Code number identifies location of item in Keep Informed Section—beginning page 161.

MECHANICAL ENGINEERING—JUNE 1958—**Keep Informed Section**

K-1	K-12	K-23	K-34	K-45	K-56	K-67	K-78	K-89	K-100
K-2	K-13	K-24	K-35	K-46	K-57	K-68	K-79	K-90	K-101
K-3	K-14	K-25	K-36	K-47	K-58	K-69	K-80	K-91	K-102
K-4	K-15	K-26	K-37	K-48	K-59	K-70	K-81	K-92	K-103
K-5	K-16	K-27	K-38	K-49	K-60	K-71	K-82	K-93	K-104
K-6	K-17	K-28	K-39	K-50	K-61	K-72	K-83	K-94	K-105
K-7	K-18	K-29	K-40	K-51	K-62	K-73	K-84	K-95	K-106
K-8	K-19	K-30	K-41	K-52	K-63	K-74	K-85	K-96	K-107
K-9	K-20	K-31	K-42	K-53	K-64	K-75	K-86	K-97	K-108
K-10	K-21	K-32	K-43	K-54	K-65	K-76	K-87	K-98	K-109
K-11	K-22	K-33	K-44	K-55	K-66	K-77	K-88	K-99	

PLEASE SEND me more complete engineering information on the items featured above.

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

CITY and STATE.....

Need more engineering information on products featured in this issue?

USE THE POSTAGE-FREE CARDS . . .

If you would enjoy receiving additional engineering information on any of the products

advertised in this issue or
detailed in the Keep Informed Section

. . . . . circle the page numbers of these advertisements or items . . . . . fill in your name and mail to us. Your requests will be promptly forwarded. All information will be directed to you.

(Note: Students write direct to manufacturer.)

FIRST CLASS
PERMIT No. 1144
NEW YORK, N. Y.

BUSINESS REPLY CARD

MECHANICAL ENGINEERING
29 West 39th Street
New York 18, N.Y.

MAIL THIS CARD

after circling the page numbers and filling in your complete address.
NO POSTAGE REQUIRED

FIRST CLASS
PERMIT No. 1144
NEW YORK, N. Y.

BUSINESS REPLY CARD

MECHANICAL ENGINEERING
29 West 39th Street
New York 18, N.Y.

MAIL THIS CARD

after circling the item numbers and filling in your complete address.
NO POSTAGE REQUIRED

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Speed Reducers

Four new worm gear speed reducers with $^1/_3$ to 5 hp input recently announced by Foote Bros. Gear and Machine Corp., extend the Hygrade line down to units with center distances of 2 in.

The new units are designed to combine maximum load carrying capacity with minimum center distances consistent with practical design and operating conditions.

Each of the four types—type S (worm at bottom), type T (worm at top), type L (low base vertical output shaft-up), and type H (high base vertical output shaft-down), are available in four sizes: 2, $2^3/_8$, $2^7/_8$, and $3^3/_8$ in. center distances.

Each size is available in $10^1/_3$:1, $20^1/_2$:1, 30:1, 40:1, 50:1, and 60:1 ratios.

The wide-faced worm gears used in the new reducers are made of virgin alloy bronze. The worm gear shafts are drop forged steel. The mating worm and shaft are alloy steel, carburized, hardened and ground. Extra capacity radial and thrust ball bearings are used on the worm shaft, while tapered roller bearings are provided for the worm gear or output shaft. An improved neoprene spring-backed lip seal is used. **—K-56**

BUSINESS NOTES

New Plant Built

Miniature ball bearing operations of Federal-Mogul-Bower Bearings, Inc. is being expanded substantially with the construction of a new plant for the company's Microtech subsidiary in California.

The new 23,000 sq ft plant is located in El Monte, Calif. The present leased facilities in Pasadena are being vacated.

New Plant Opens

Precision Rubber Products Corp. announces the opening of a new 20,000 sq ft plant at Lebanon, Tenn.

All products of the company will be manufactured in the new plant. In making the announcement, the company stated that the additional facility had been built in order to service the firm's rapidly expanding business.

Epoxy Resin Plant

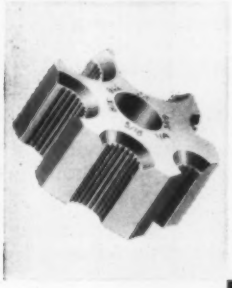
A new plant for the production of Bakelite liquid epoxy resins is to be built at Marietta, Ohio, according to an announcement by Union Carbide Corp. The facilities, scheduled for commercial operation early in 1959, will have a rated annual capacity of 15,000,000 lb of epoxy resins.

GIVING YOU

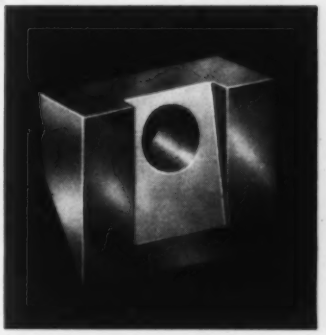
...the best and most modern!

Bunting today covers a new area in the engineering and manufacture of bearings and machine parts. To the traditional line of Bunting Cast Bronze Bearings and parts is added up-to-date, soundly established facilities for engineering and manufacturing bearings and parts made of Sintered Powdered Metals.

In an entirely new plant with the very latest equipment, Bunting now attains the position in the Sintered Powdered Metals field which it has long held in the field of Cast Bronze Bearings.



A competent group of Bunting Sales Engineers in the field and a fully staffed Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.



Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

ENGINEER OPPORTUNITIES AT RAYTHEON

DOPPLER NAVIGATION EQUIPMENT is readied for flight testing under operational conditions. Engineers at the Maynard Laboratory hold responsibility for program from initial study phase through prototype production.

Newly formed project groups solve complex airborne radar problems

Engineers like the project-type organization at Raytheon's Maynard Laboratory. It gives them maximum diversification in their work on the most advanced radar navigational and control problems of the day.

At Maynard, you'll find projects involving many areas of aircraft navigation and guidance systems . . . doppler navigation, velocity check systems, night-fighter operations systems, flight-control systems, altimeters. There is also interesting new work on countermeasures equipment.

Career opportunities for men at all levels now exist in the following areas:

MECHANICAL DESIGN PACKAGING
ELECTRO-MECHANICAL PRODUCT DESIGN
STRUCTURES • PRODUCTION ENGINEERING
METHODS & PROCESS ENGINEERING
METALS PROCESSING • HEAT TRANSFER

For complete details on engineering positions in any of Maynard's project groups, please write John J. Oliver, P.O. Box 87M, Raytheon Maynard Laboratory, Maynard, Mass.

RAYTHEON MANUFACTURING COMPANY
Maynard, Massachusetts

Are you the ONE MAN IN THREE?

RAYTHEON

Excellence in Electronics

MAYNARD LABORATORY

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Synthetic Rubber Plant

Du Pont has announced that a plant is nearing completion at Deepwater Point, N. J., to produce a new fluorine-containing elastomer called Viton synthetic rubber. Company spokesmen said no commercial elastomer equals Viton in resistance to oils, fuels, and solvents at temperatures above 400 F. Du Pont describes this development as a major break-through in elastomer chemistry.

LATEST CATALOGS

Composite Metal

Chicago Bridge & Iron Co., has published a 32-page brochure describing the manufacture of Hortonclad, a composite metal produced by a flux-free high strength bonding process which provides an integral and continuous bond between an alloy or special metal and its backing plate.

The publication explains the manufacturing process and lists a variety of available cladding and backing metals. It also outlines research, design, fabrication and erection facilities, including field stress relieving and field x-raying. **—K-57**

Optical Projectors

A 16-page booklet which describes the features of the various contour projectors and details the various applications for optical gaging in the toolroom, on the production line, in receiving, and in final inspection is now available from Eastman Kodak Co.

A feature of the booklet is a specifications chart which lists such features of individual projectors as clear screen diameter, real field diameter, throat clearance, workable capacity, table travel, lens height above table, helix table travel, angular measuring capacity, approximate weight and required floor space. **—K-58**

Safety-Relief Valves

Information for selection and sizing of all nozzle safety-relief valves manufactured by Farris Engineering Corp., is included in a new specifications catalog. The catalog restricts itself to valves applicable to process piping.

Included in the forty-four-page catalog is information on standard and BalanSeal bellows varieties of safety-relief valves, as well as a data section containing sizing factors and formulas; nozzle capacity charts for air, water, gas, and steam, and dimension and weight tables. **—K-59**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Forged Steel Flanges

Two technical data cards have been released by Tubular Products Div., Babcock & Wilcox Co.

Card FDC-251 gives approximate weights of sizes and types of forged steel flanges, while card FDC-250 supplies the weights of eight different types of welding fittings in a full list of sizes. —K-60

Metal Castings

Meehanite Metal Corp., offers a 20-page illustrated booklet titled, "How to Machine Meehanite Castings."

The bulletin presents an accumulation of machining data of various types of castings, divided according to the type of machine tool on which the operation is performed. It gives details on feeds, speeds, depths of cut, type of tool. —K-61

Cold Storage Booklet

A manual dealing with vermiculite for low-temperature insulation has been made available by Zonolite Co.

The eight-page booklet gives information on vermiculite refrigeration fill, insulating concrete mixes, and asphalt-bound vermiculite for cold storage floor construction. Suggestions for proper vapor-barrier treatment are included, as well as specifications and physical data on various products. —K-62

Ceramic Magnet Pulleys

Stearns Magnetic Products announces a booklet describing its Series 410 and 710 Indox V permanent magnet pulley for tramp iron separation in belt conveyor systems.

Performance advantages of the new permanent magnet pulleys over electromagnetic types are discussed, with an explanation of the efficiency achieved by the firm's radial pole design. —K-63

Feedwater Regulator

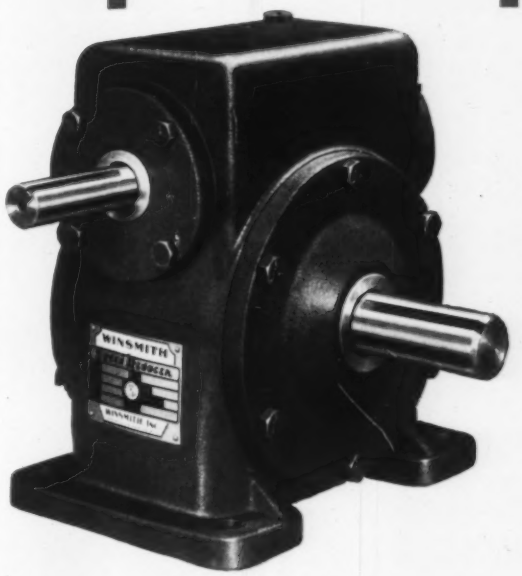
Bulletin 1045, published by Copes-Vulcan Div., Blaw-Knox Co., describes the firm's Flowmatic D-O feedwater regulator. It utilizes steam-flow and water-level influences acting through a thermostatic tube and direct-operated regulating valve.

The four-page bulletin explains, through a schematic diagram, the application principles of the feedwater regulator, and gives specifications of the various integrated parts. —K-64

Metalworking Presses

Lake Erie Machinery Corp., has issued a 12-page bulletin, No. 7.13, describing applications and advantages of double and triple action hydraulic four column metalworking presses for deep metal drawing. Included illustrations and general specifications of presses ranging from 75 to 4000 tons. —K-65

all the way
up to 34 hp!



Winsmith worm gear speed reducers

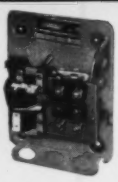
For top performance on your big jobs, Winsmith Worm Gear Speed Reducers are available for any application up to 34 horsepower. Compact, efficient, economical — with endurance to spare — Winsmith Speed Reducers offer you the most complete line of standard models, sizes and drive arrangements from a single source. For speed reducer requirements all the way down to 1/100 hp, you'll find it pays to specify Winsmith.

WINSMITH SPEED REDUCERS

WRITE TODAY FOR CATALOG NO. 155 for useful information on selection, operation and maintenance of the hundreds of sizes and types of Winsmith Speed Reducers

WINSMITH, INC. 20 Eaton Street, Springville, (Erie County), N. Y.

MERCOID®
MERCURY SWITCH
RELAYS



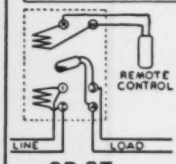
FOR VOLTAGES TO 440 ac or dc

NO SPRINGS OR CLAPPERS

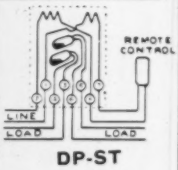
NO WELDING OF CONTACTS
NO MAINTENANCE REQUIRED

The operation of a Mercoid Transformer-Relay has several advantages over clapper type relays. In principle, it is a low voltage transformer—the two coils of which, operate as a repulsion relay.
The primary coil is fixed in position and connected across the high voltage line. The secondary coil is movable and is connected to the control circuit.
When the control circuit is closed, the secondary coil instantly moves upward by repulsion action, thereby operating the hermetically sealed mercury contact. When the control circuit opens, the secondary coil drops by gravity restoring the mercury contact to its original position.

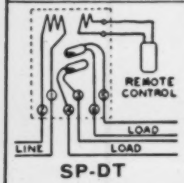
Hundreds of circuit arrangements are available—a few typical examples are shown below:



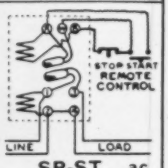
SP-ST
ac



DP-ST
dc



SP-DT
ac

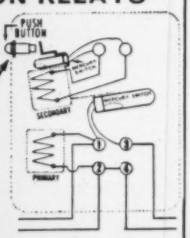


SP-ST ac
start-stop

PUSH BUTTON RELAYS

Available for various circuit arrangements.

Push button to open circuit when relay is energized (circuit will automatically close when relay is de-energized.)



WRITE FOR BULLETIN NO. 31

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Drafting Equipment

Anco Wood Specialties, Inc., has issued bulletins describing its wood and steel base drafting tables. The units are illustrated, and features of each age enumerated. —K-66

Electric Furnace Products

A. M. Byers Co., has issued two bulletins dealing with electric furnace products.

One gives sizes and specifications on electric furnace quality carbon steels. The other covers Amballoy specialty steels and shows their use in furnace applications. —K-67

Cushioned Float Valve

Golden-Anderson Valve Specialty Co. announces Bulletin W-5, illustrating and describing its cushioned float valves.

The units are designed for liquid level control in tanks, standpipes, reservoirs, vats, bins, and water heaters. Integral pilot operated and remote pilot operated valves are shown. Diagrams show construction features and dimensions. —K-68

Precision Stock Gears

Dynamic Gear Co. has issued Catalog E-88 with supplements, on its line of precision stock gears.

Included in the 88-page booklet are dimension diagrams and tables on such units as anti backlash gears, bevel gears, cam type spur gears, clamps and collars, differentials, compound gear assemblies, nylon spur gears, shafting, shim spacers, skip clutches, standard hubless spur gears, standard hub type spur gears and worms, and mating helical gears. —K-69

Blending System

A 16-page technical bulletin, B-2, describing Fuller Company's new Airmerge system for the exact blending of dry pulverized materials is now available.

The bulletin's eight illustrated sections discuss the complete operation, including installation, blending problems, and explanation of how the system's various components function. Photographs and cut away line drawings show how dry materials are homogenized by combining quadrant blending and pulsated aeration. Other illustrations detail the system's various blending methods: the batching scheme, and continuous operation. —K-70

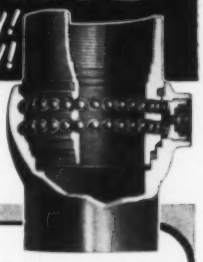
ALWAYS NEEDED

ALWAYS THERE

SWING YOUR LIQUIDS INTO LINE

OPW
swing joints
SWING EASY! FLOW EASY!

- BRONZE
- STEEL
- ALUMINUM
- MONEL



Full Unrestricted Flow • Effortless Movement • Greater Load Carrying Capacity • "O" Ring Sealed Contamination Free Operation • Perfect Alignment

FREE CATALOG F-8 provides engineering data, sizes, styles, recommendations and prices.

JORDAN CORPORATION
INDUSTRIAL SALES DIVISION OF OPW CORP.
6013 WIEHE ROAD
CINCINNATI 13, OHIO
Phone ELmhurst 1-1352

VISCOSITY OF LUBRICANTS UNDER PRESSURE

This Report reviews twelve experimental investigations made in England, Germany, Japan, Russia, and the United States on 148 lubricants comprising 25 fatty oils, 94 petroleum oils, 17 compounded oils, and 12 other lubricants. Data collected are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Pertinent topics such as experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Other sections give the required computation of temperature and pressure coefficients, a bibliography of 189 items, and symbols.

1954 $5.00
(20% Discount to ASME Members)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 W. 39th St. New York, 18.

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Hydraulic Cylinders

An illustrated bulletin, 71000, on its line of 2000 psi double-acting hydraulic cylinders has been released by Oilgear Co.

The new line of foot lug, center lug, front flange, rear flange, and clevis mounting cylinders is described in copy supplemented by illustrations and dimensioned installation drawings of the standard 2 to 8 in. bore sizes. —K-71

Hot Rolled Steels

Joseph T. Ryerson & Son, Inc., has issued a buyers' guide to hot rolled steel bars, structurals, plates, sheets, and strip. Cutting services are illustrated and described, along with specification details and size ranges. —K-72

Sand, Slurry Pump

Krogh Pump & Equipment Co., Inc., 515 Harrison St., San Francisco 5, Calif. announces Bulletin 601 which describes its newly developed Model 600 sand and slurry pump.

The bulletin gives specifications for the pump which is fully lined with replaceable and interchangeable hard metal and rubber liners. A cross-sectional view shows construction details and a complete parts list. A dimension diagram. —K-73

Feedwater Self-Purification

Technical Reprint T-157, "Breakthrough in Condensate Purification," is available from Graver Water Conditioning Co.

The paper discusses the use of the new principle of internal self-purification of condensate in sub-critical as well as supercritical operations. Internal self-purification is accomplished by a scavenger-demineralizer system within the boiler-turbine cycle. The result is ultra-pure feedwater and condensate in the range of parts per billion instead of the usual parts per million. —K-74

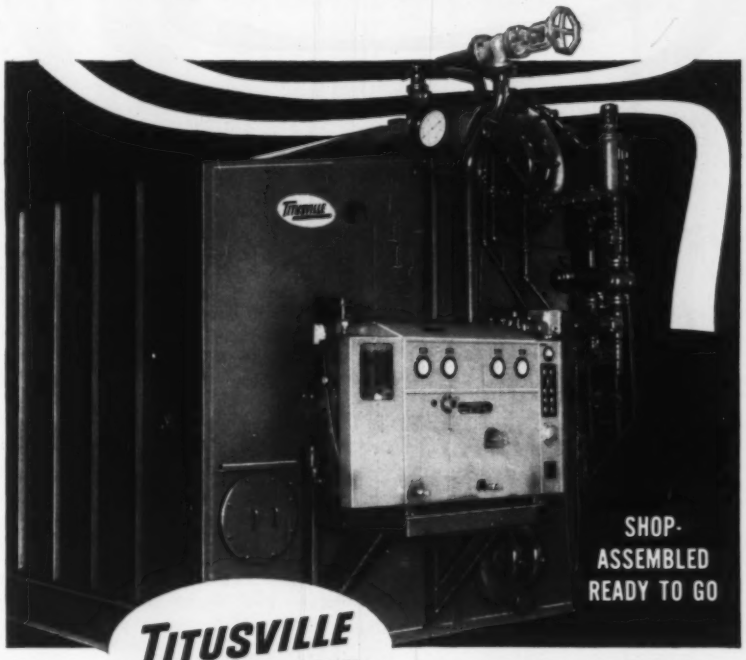
Special Bearings

Design requirements for anti-friction bearings of unusual shapes and sizes, and current information on suitable bearing component materials for high-temperatures, corrosion resistance, nonmagnetic properties, and other specialized operating conditions, are described in Bulletin AFB-2 prepared by Industrial Tectonics, Inc.

The bulletin includes illustrated case histories of ball and roller bearings manufactured to customer specifications. Line drawings indicate the range of typical bearing designs and modifications available for critical military and industrial applications. —K-75

Use a CLASSIFIED ADVERTISEMENT
for Quick Results

10,000 pounds to 60,000 pounds of quality steam per hour



TITUSVILLE BOILERS SINCE 1860

TYPE WTP PACKAGED STEAM GENERATOR

Write for your copy of new Bulletin B-3255

The Titusville WTP Steam Generator's ease of installation and simplicity of operation are matched by the economy and dependability in operation that make this water-tube unit a standout in value year after year! Completely shop-assembled, requiring no special foundations, high stack or induced draft fan, the Titusville WTP is ready to serve you the moment service connections are made. *Let us discuss your needs.*

THE TITUSVILLE IRON WORKS CO.

A Division of

Struthers Wells

TITUSVILLE, PENNSYLVANIA

Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement

Plants at Titusville, Pa. and Warren, Pa.

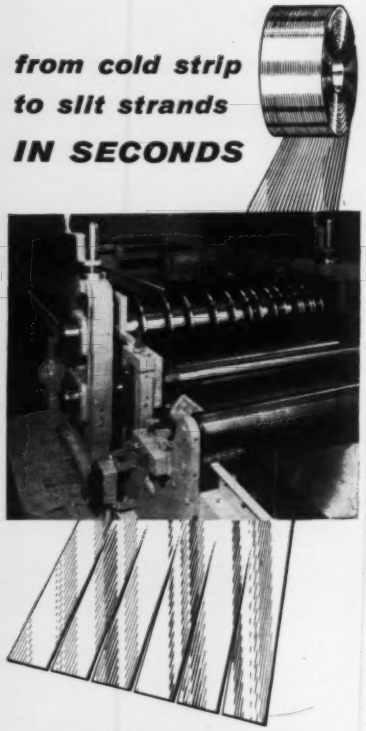
Offices in Principal Cities

BOILER DIVISION
BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

PROCESSING EQUIPMENT DIVISION
Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

FORGE DIVISION
Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

from cold strip
to slit strands
IN SECONDS



YODER ROTARY MULTIPLE SLITTERS

A Yoder slitter converts mill-width coils of flat-rolled metal into many variable-width strands in amazingly short time. Speed, coupled with great accuracy and low manpower requirements, makes a Yoder slitter an important factor in keeping production and overhead costs down.

Operated by only two men, the Yoder Type 3-48 slitter illustrated is designed to accommodate standard mill-width coils up to 48 inches wide, in a variety of metals and thicknesses. The slit strand widths can be held to within a .004" tolerance.

Even if your steel requirements are as little as 100 tons a month, the savings to be realized in time, manpower and raw material costs alone will pay for a Yoder slitter in the first few months of operation.

There is a Yoder slitter designed and engineered to meet your requirements, and to speed the delivery of "special" width stock in a wide range of large or small sizes. Send for your free copy of the fully-illustrated, 76-page booklet, "Multiple Rotary Slitting Lines."

THE YODER COMPANY
5499 Walworth Avenue • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING
ROTARY SLITTING LINES

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

High Pressure Compressors

Joy Mfg. Co. announces the availability of Bulletin A-93, covering four models of its high pressure compressors for soot blowing, chemical processing, and gas compression.

The units are rated at 100 to 500 hp, 300 to 500 psig, 368 to 2000 cfm. A quick selector chart is included in the 8-page bulletin, along with specifications and dimensions and photos of the units. **—K-76**

Insulation Booklet

A 12-page booklet, on its Thermalastic insulation system for large motors and generators, synchronous condensers and frequency changers, is available from the Westinghouse Electric Corp.

The advantages of the insulation, said to extend the life of heavy rotating equipment in hard service, are presented. Laboratory test charts are discussed showing lower power factor, higher tensile strength, greater voltage endurance and dielectric strength, and waterproof characteristics of the insulation. **—K-77**

Magnets, Magnetizers

Catalog No. PR-19, describing stock permanent magnets, magnetizers, and demagnetizers, has been released by Indiana Steel Products Co.

The catalog lists more than 70 cast Alnico V magnets and over 30 sintered Alnico II magnets available for immediate shipment in experimental quantities. In addition, demagnetizers and electro and permanent magnetizers are offered. **—K-78**

Vibrating Feeders

Cleveland Vibrator Co. is offering a new illustrated bulletin covering its line of air-operated vibrating feeders.

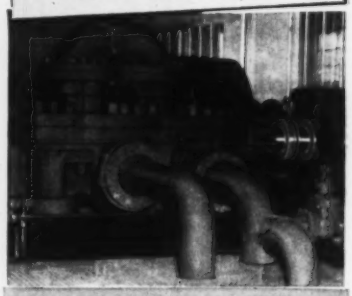
The feeders, which are available in lengths from 24 to 15 ft, will closely control feeding rates. Materials may be feed from 0 oz per hour up to maximum poundage by changing operating air pressures. The smaller feeders move 250 lb of small metal parts per hour, while the larger ones move 200 tons of damp sand per hour, the firm claims. **—K-79**

Packings, Gaskets

A packing handbook which details a variety of packings, gaskets, and seals and their materials of construction and uses, has been published by Garlock Packing Co.

Designated Bulletin AD-162, the handbook contains a detailed table listing the effect of numerous gases, liquids and solvents on packing materials from metals to synthetics to leather. Included is data on static sealing including gasketing such as die or lathe cut and sheet; molded, extruded, or machined types, and asbestos-metallic spiral wound gaskets. **—K-80**

THOMAS FLEXIBLE COUPLINGS PROTECT Your Pumps



NO LUBRICATION
NO MAINTENANCE
NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.
They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES.

1 Freedom from Backlash Torsional Rigidity
2 Free End Float
3 Smooth Continuous Drive with Constant Rotational Velocity
4 Visual Inspection While in Operation
5 Original Balance for Life
6 No Lubrication
7 No Wearing Parts
8 No Maintenance

Write for Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

View of the huge Cleveland Worm and Gear set used in this 150 Series All-Steel Shear, built by The Cincinnati Shaper Co.

CLEVELAND gearing helps this giant shear 1½" steel plate

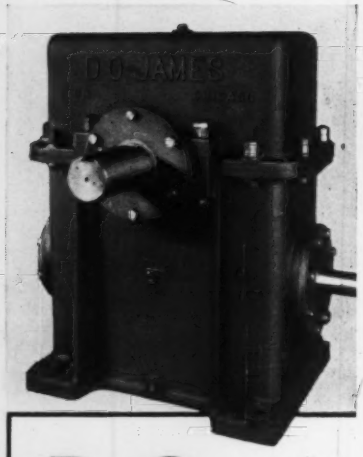
THE terrific pressures generated in cutting a 1½" steel plate 12 feet long are as nothing to this giant shear. Reason: Because there is plenty of extra power, transmitted through Cleveland Worm Gearing.

Whenever a drive must operate under extreme pressures, there you'll find Cleveland Worm Gearing at its best. And a Cleveland drive stays dependably on the job no matter how severe the service. It doesn't wear out—its efficiency actually improves with use.

Write for Bulletin 145 which illustrates the many types and sizes of units available in Cleveland Worm Gear Speed Reducers and Drives. Our sales representative near you will sit down with you at your convenience to analyze your drive problems and help you select Clevelands best suited to your needs. The Cleveland Worm and Gear Company, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

CLEVELAND
Worm Gear
Speed Reducers



D.O. JAMES

WORM GEAR SPEED REDUCERS

THE D.O.James Worm Gear Speed Reducers cover a wide range of ratios and horsepowers . . . and feature the advantages of right angle shaft arrangement, minimum of moving parts, accurate meshing of precision produced worm gearing, anti-friction bearing mountings and tested lubrication. The proven efficiency, long life and compactness of this type of gear reduction makes them the "MUST Reducer" for many power saving installations.

They are designed and built by an organization that has been making Gears and Gear Reducers for Seventy Years. May we serve you?

Extensive Worm Gear Making Facilities

D. O. James Worm Gear teeth are generated on tangential feed hobbing machines by tapered and ground hobs. We make worm gears from 1" to 80" in diameter and from 24 DP to 1 DP.

D.O. JAMES
GEAR MANUFACTURING CO.
1140 W. Monroe Street, Chicago, Illinois

Since 1888
MAKERS OF EVERY TYPE OF GEAR AND GEAR SPEED REDUCER

SEND FOR CATALOGS
Catalogs and price lists covering worm gear speed reducers (the right angle drive) are available to power transmission engineers. Please request on Company Letterhead — we'll mail your copy at once.

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Pump Selector

Just released by Nagle Pumps is a pump selector bulletin, 158, which briefly describes the types of pumps, all of which are for such applications as those involving corrosion, abrasion, high temperature, or a combination of them. —K-81

Cellar Drainers

Deming Co. has recently completed Bulletin No. 4660-C, on its submersible cellar drainers.

The motors are said to be waterproof cast iron housings and the company reports that the same pump can be applied to pumping corrosive septic tank effluent. The bulletin gives data on the Fig. 4664 and 4667-B submersible cellar drainers. General construction features, motors, float switches, and wire connections are presented. A table gives pump figure number, pipe connection inches, minimum diameter sump which the pump will fit, total head in feet and approximate shipping weights. —K-82

Gas Regulators

Oxweld industrial gas regulators are described and illustrated in a 20-page catalog available from Linde Co., Div. Union Carbide corp.

The catalog includes specifications and ordering information for 47 regulators that are available for use with all industrial gases. Inlet and outlet connections are listed according to the American Standards of the Compressed Gas Association. —K-83

Temperature Controls

Nine different types of temperature controls are described in a new condensed catalog offered by Fenwal Inc.

Included are cartridge-style Thermoswitch units for general industrial use, midget and miniature models for tight-spot applications, surface mounting and high current capacity designs, Detect-a-Fire units for overheat or fire protection, two different thermistor controllers, and new mechanical indicating controller. Temperature and current ratings are given for all models. —K-84

Volute Pumps

Low- and high-head mixed flow volute pumps for sewage disposal, drainage, flood control, irrigation, raw water pumping, or for any relatively clear liquids are described in a new six-page two-color catalog, F-102, available from the Economy Pump Div. C. H. Wheeler Mfg. Co.

Design and construction details for horizontal and vertical mixed flow volute pumps are presented. Units are built in 12 through 72 in. sizes, and in 3000 to 150,000 gpm capacities, heads up to 180 ft. —K-85

Yes...

McDONNELL CONTROLS FOR BOILERS TO 250 psi.

McDONNELL 92 SERIES
Pump Control, Cut-Off and Alarm Switch
Underwriters' Listed
C. S. A. Approval No. 5545

Here's a whole new concept of control design and performance . . . with the best-known name in its field. Introduces repulsion magnetic switching, for positive opening and closing. Beats the heat as never before—okayed for 75° C. (167° F.) wiring. Has extra generous float clearances; operating levels that are not affected by pressure changes; and a host of other refinements.

Write for Bulletin L-123

Shows 92 Series models with or without integral water column. Has full engineering data for controlling pumps or electric valves on boiler or tanks, for low water cutoff and alarm, etc.
Also shows companion 91 Series, for pressures to 150 psi.

McDONNELL & MILLER, INC.
3510 N. Spaulding Ave., Chicago 18, Ill.

McDONNELL
Boiler Water Level Control

NATIONAL AIROIL

Oil Burners

OF THE STEAM AND MECHANICAL TYPES NOW COMBINED INTO

Dual Stage BURNERS

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

46 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed descriptions, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNER
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
AIR INTAKE DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

Established 1912 — Incorporated 1917

NATIONAL AIROIL BURNER CO., INC.

1239 E. Sedgley Ave., Philadelphia 34, Pa.

Southwestern Div: 2512 So. Blvd., Houston 6, Texas

KEEP INFORMED

BUSINESS NOTES — NEW EQUIPMENT — LATEST CATALOGS

Reducers, Gears

Ohio Gear Co. has published Catalog 570, covering its line of speed reducers, stock gears, and special gears.

The pocket-sized booklet includes photos, dimension diagrams, and ratings of each type of equipment offered. Engineering data on selection of reducers and material on installation, lubrication, and maintenance is also covered. —K-86

Rotary Shock Absorbers

Houdaille Industries, Inc., announces Form No. RSA457, an eight-page bulletin that illustrates and describes its rotary shock absorbers for the highway transportation and prime moving industries.

The booklet gives installation dimensions and has charts showing installation data requirements, shock absorber resistance, and resistance-angular velocity. —K-87

Glassed Centrifugal Pump

A 16-page booklet on the glassed centrifugal pump has been jointly issued by Goulds Pumps, Inc. and The Pfaudler Co., Div. Pfaudler Permutit Inc.

Included are a brief history of the development of the pump and answers to more than 30 of the most frequently asked questions about the pump by chemical and process engineers. —K-88

Electrode Selection

How to select the most efficient electrode for any particular welding job is the subject of a new 12-page weldirectory published by Lincoln Electric Co. To help select the best electrode for overhead, downhand, sheet metal, or other work, the bulletin describes the basic characteristics of each family of electrodes. This description includes deposition, arc action, amount of slag, bead appearance, and general applications. It also differentiates between individual electrodes within the family and gives physical properties, current ranges, sizes, and welding procedures for each electrode. —K-89

Permanent Smoke Stack

Information on a permanent, low cost refractory smoke stack for commercial and industrial applications is contained in an eight-page folder available on request from Van-Packer Co., Div. of Flintkote Co.

Subject of the folder is the firm's prefabricated refractory stack, a centrifugally-cast stack available in seven diameters. The folder gives product information, applications with boilers, furnaces, and incinerators, installation methods, mechanical specifications, and test data. —K-90

Pantex SPEEDYLECTRIC STEAM GENERATOR

Ideal Answer to **10 PROBLEMS** in Supplying Steam

- Without flame, flues or stack
- At higher pressures or temperatures
- At adjustable pressure or temperature
- With a constant high quality
- Without long steam lines
- To serve summer processing needs
- To meet extra load needs
- For lab, test, or pilot-plant use
- Where an unattended boiler is desired
- Where boiler space is limited

In many such situations, a Speedylectric Steam Generator is the best or only solution. Using the electrode method of generating steam electrically, completely safe anywhere, its design eliminates low-water hazard and practically removes the need for supervision. Generation is fast, by the simplest and most economical electric method, and adjusts automatically to meet load demand. Upkeep is nil . . . there are no coils, tubes or heating elements to scale or burn out. Sizes from 2 to 50 Bhp, 15 to 500 psi. Higher pressures are available. Electric power 220, 440, or 550 volts A. C. UL listed, ASME code.

FOR YOUR FILE

Send for Bulletin SG-100 or see our listing in "Sweet's Plant Engineering File."

PANTEX MANUFACTURING CORPORATION

Box 660AJ, Pawtucket 6, R. I.

Send me Bulletin SG-100 . . . free

Name_____

Title_____

Company_____

Address_____

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Filters, Precipitators

Dollinger Corp., has available three bulletins on its filters and precipitators.

Bulletin 200 covers pipe line filters for air and other gases; 300, liquid filters for water, chemicals and petroleum products; 400, its new precipitator for electronic air cleaning. Cutaway photos show design features and specifications, and dimensions of the various units are included in the bulletins. —K-91

Roller Conveyor

A four-page bulletin on 2 in. diam. rapid-roller gravity conveyor has been issued by Rapids-Standard Co., Inc., Grand Rapids, Mich.

The conveyor can be used for medium duty in industry handling packaged goods. It is said to be adapted to handling objects that have one firm, free-running surface, such as boxes, crates, drums, cans cartons —K-92

Loading Assemblies

A 24-page catalog, F-32R, describing loading assemblies and accessory products, is announced by Jordan Industrial Div., OPW Corp.

The illustrated catalog contains product descriptions and photos, dimensional drawings, installation layouts, and selection instructions. Loading assemblies are flexible, no-leak piping devices for loading and unloading liquid storage tanks, tank cars. —K-93

Meter Mountings

A four-page product bulletin describing a patented, low-cost, bonded rubber meter mounting for protecting sensitive instruments against shock and vibration is available from Lord Mfg. Co.

Bulletin No. 601 contains information on design features, advantages, and performance of the mountings. Installation photographs pin-point typical applications. Specifications include an application cross-reference table listing various meter manufacturers' models. —K-94

Separators, Thickeners

Rex float-treat separators and thickeners are described in a bulletin published by Chain Belt Co.

The system is a process in which suspended organic matter and chemical flocs are removed from process water by flotation. The firm says it has application in industry for recovering petroleum products, grease, fats, fibers, animal hair, flocculent solids and in sewage plants to remove settleable solids, to provide overload relief to existing facilities, to provide greater solid concentration in sludges. —K-95

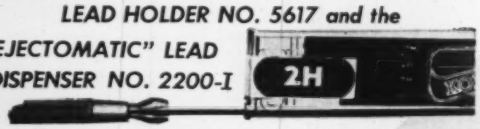
Flame-Cutting Machines

Oxweld flame-cutting machines are described in a 28-page catalog available from Linde Co., Div. Union Carbide Corp.

The machines range in size from small portable machines that can be carried around a shop by one man to large multi-blowpipe shape-cutting machines capable of reproducing thousands of intricate patterns in steel. Also included are specifications for each machine, illustrations of typical installations, and a description of machine accessories such as automatic and magnetic tracing units. —K-96

KOH-I-NOOR

THE KOH-I-NOOR ADAPTO-CLUTCH DRAFTING LEAD HOLDER NO. 5617 and the "EJECTOMATIC" LEAD DISPENSER NO. 2200-I



No more wondering what degree of lead your holder contains — just dial Indicator to the lead you have inserted to any one of the 17 degrees.

Eye-Cue INDICATOR

SUCCESSFUL ENGINEERS AND ARCHITECTS PREFER KOH-I-NOOR

KOH-I-NOOR RAPIDOGRAPH NON-CLOGGING "TECHNICAL" FOUNTAIN PEN.

As easy to use as a pencil.

Excellent for drawing, tracing, inking-in, lettering and anything requiring reproduction. Uses either India, Drawing, or Fountain Pen Inks.

In 5 precision line widths

#00 Extra Extra Fine, #0 Extra Fine, #1 Fine, #2 Medium, #3 Broad. Color-coded caps for quick degree indentification.

KOH-I-NOOR KOH-LINER NO. 3100 (12") NO. 3101 (19")

For rapid drawing of parallel lines. Set the dial for desired equi-distance, then just push the button and draw the line.

The 11 line spacings from 1/32" to 1/4" are automatic with full choice of in-between settings. Simple ruler adjustments regulate varying angles from 0° to 15°, 30° and 45° above or below the horizontal line.

KOH-I-NOOR PENCIL COMPANY, Inc.
BLOOMSBURY, NEW JERSEY

For Consulting Engineers
Turn to Page 240

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Rotary Equipment

Heyl & Patterson, Inc., has announced publication of bulletins on its centrifugal equipment for industry.

One bulletin covers its rotary car dumper for steel, coal, power and cement application. Another gives data and specifications on centrifuges, separators, continuous centriplanes, and vertical centrifugals. One bulletin deals with the firm's cyclone for slurry thickening, slurry classification, water clarification, and recovery of suspended solids. —K-97

Couplings, Fittings

Charles E. Manning Co. has issued Technical Bulletin 100 covering its standard Series 1000 and lightweight Series 500 malleable iron aluminum couplings for oil, gas, water, air and chemical pipelines.

The four-page folder contains dimension diagrams and tables, and illustrates the various units. —K-98

Time-Impulse Telemetering

An eight-page bulletin describing how telemeters enable users to observe and record the operation of widely scattered meters at a central location from any distance is announced by Builders-Providence, Inc., Div. of B-I-F Industries, Inc.

The bulletin contains illustrations, schematic diagrams, performance charts and explanatory text. It shows how the units can be adapted to such applications as metering, observing and recording fluid flow, position, liquid level, and temperature. —K-99

Soot Blowers

Long retractable soot blowers is the subject of Bulletin 1043, recently published by Copes-Vulcan Div., Blaw-Knox Co.

The bulletin describes the special design features such as dual drives—separate motors (either air or electric) for rotating and traversing the lance—blowing medium valve control, flexibility of mounting. —K-100

Reproduction Materials

A booklet outlining ways in which Kodagraph reproduction materials can provide short cuts and savings in reproduction departments, drafting rooms, and in the field, has been published by Eastman Kodak Co.

The 12-page booklet diagrams applications for the materials to protect original drawings, simplify print distribution, restore old and worn drawings, reproduce blueprints and direct-process prints, speed revision of drawings, permit combining of standard designs, and save drafting time with photo drawings. —K-101

Power Units

Syntron Co. announces publication of a selenium rectifier a-c to d-c power unit catalog.

The illustrated 10-page booklet contains data and specifications for standard model and special underground service power units, and standard and station-type battery chargers. —K-102

Pressure Piping

A 48-page bulletin, published by Tubular Products Div., Babcock & Wilcox Co., summarizes and correlates the various specifications of the ASA code for pressure piping, B31.1 and B31.1.8—1955, and the ASME Boiler and Pressure Vessel Code (Section I, Power Boilers, 1952 and Section VIII, Unfired Pressure Vessels, 1956). —K-103

Select the CONTROL you want for Automatic Valve Operation . . .

***with the G-A Cushioned* FLOWTROL VALVE**

• Operates automatically with any fluid, any control • Angle or globe body, bronze or non-corrosive liner • Air and fluid cushioning prevent hammer in closing • Available sizes 2" to 36" for pressures to 250 psi

GOLDEN ANDERSON Valve Specialty Company

1223 RIDGE AVENUE, PITTSBURGH 33, PA.

Write for Bulletin W-8A

Designers and Manufacturers of VALVES FOR AUTOMATION

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

PVC Pipe

A. M. Byers Co., has issued a 30-page manual on its pvc pipe.

Included is data on general characteristics, dimensions, principal applications, corrosion resistance, recommended working pressures, vacuum service, head loss, and installation for Type I and Type II pipe. —K-104

Centrifugal Pumps

Pacific Pumps, Inc. has available Bulletin 128 covering Type A, AC, OV, UNI, multi-stage, centrifugal pumps developed for high temperature, high pressure, heavy duty services.

The four pumps range in size from 2 to 8 in., maximum speeds to 6000 rpm, capacities to 2700 gpm, maximum temperatures to 850 F, discharge pressures to 2000 psig, and differential heads to 4500 ft. All four pumps feature a radially split case of cylindrical form, bored to provide a clearance space between the case and internal assembly to eliminate metal-to-metal contact and facilitate removal and insertion of the rotating assembly. —K-105

Dust Collector

Hagan Chemicals and Controls, Inc., has issued Bulletin MSP-124A, which describes its aerostatic dust collector.

The unit, which operates on the principal of selective particle acceleration and which has a honeycomb design, is illustrated in cutaway drawings. —K-106

Ductile Iron

T. B. Wood's Sons Co., announces "A Case for Ductile Iron Economy," a brief for the ferrous alloy that combines the low melting point, fluidity, casting and machining advantages of cast iron with steel's strength, toughness and ductility.

The 12-page, two-color, letterhead-size bulletin shows progressively how patterns and molds are made, how the foundry charges and pours the metal, how castings are machined and finished and some of the end products. Castings may be made for tiny parts weighing only ounces or for large parts of many tons. There are practically no size nor shape limitations, states the company. —K-107

Valve Applications

Crane Co., has available its "Valve World," a publication listing applications of its valves at the Shippingport atomic station.

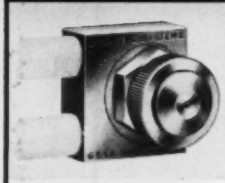
Other articles in the magazine cover valve standards, research on metals, and applications of valves in the off-shore oil-drilling and railroad industries. —K-108

Indicators, Recorders

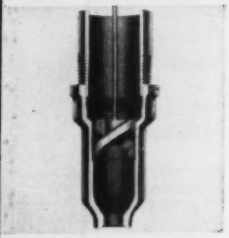
Information about electronic Speedomax G indicators and recorders for precise measurement of pressure, force, tension, and weight using load-cells is presented in a new illustrated four-page data sheet just published by Leeds & Northrup Co.

The sheet includes installation photographs of typical applications—checking static load in aircraft fuselage structural tests, recording weight of scrap charge to a foundry furnace, recording the weight of contents in 25-ton outdoor chemical storage tanks—and lists the features and specifications of the indicators and round- and strip-chart recorders. Load-cell characteristics are also tabulated. —K-109

SPRAY NOZZLES ...THAT FIT INSTALLATION NEEDS



LIMITED SPACE? Here's a pneumatic atomizing nozzle no bigger than a half dollar.

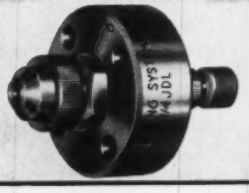


NOZZLES INACCESSABLE? Vane of this FullJet nozzle is withdrawn through pipe for easy, remote cleaning.

SIMPLIFIED WALL MOUNTING? Nozzle body acts as flange . . . fits any wall thickness. Perfect for pressurized chambers. →

Spraying Systems gives you better spray nozzle performance . . . plus a wide choice of physical nozzle shapes, sizes and assemblies. Shown here are three such typical nozzles. When the spray nozzle problem also includes installation and maintenance, perhaps we already have an easy solution. For information write for Catalog 24.

SPRAYING SYSTEMS CO.
3265 RANDOLPH STREET
BELLWOOD, ILLINOIS



Specialized Die-Cutting and Gaskets

- More than 35 years experience in die-cutting non-metallic materials.
- We are equipped to slit rubber slabs up to 12" thick — or, to die-cut materials as thin as .001" onion skin shim paper.
- Difficult adhesive coated, or impregnated materials are easily handled through our unique cutting process.
- Materials handled and stocked include paper, asbestos, fibre, rubber, cork, felt, synthetics and many miscellaneous materials.
- All steel rule dies are made in our own plant.

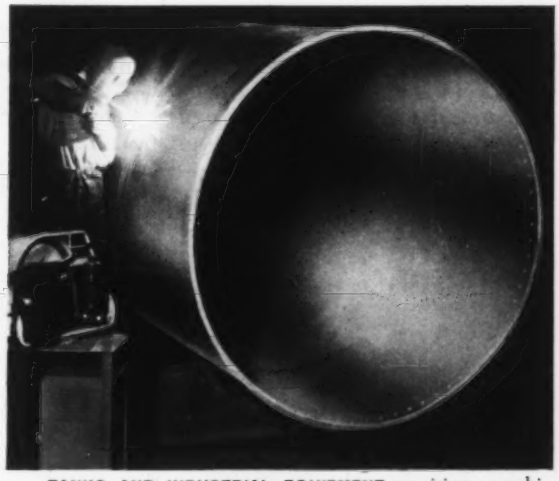
Ask about our technical and consulting service.

Rhopac, Inc.

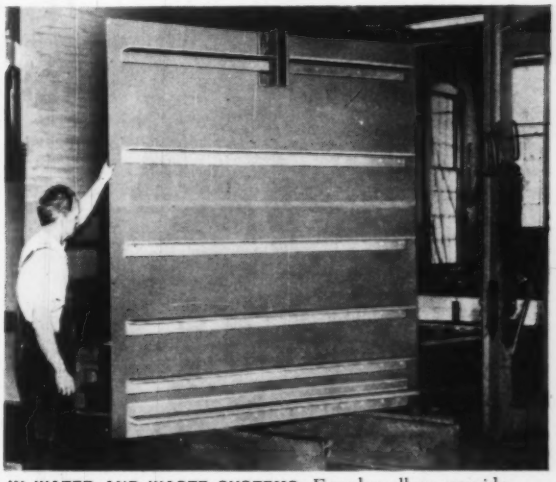
3433 Cleveland Street, Skokie, Illinois

Manufacturers of mechanical packings, industrial and boiler gaskets, radio speaker gaskets, steel rule dies, flexible packing hooks

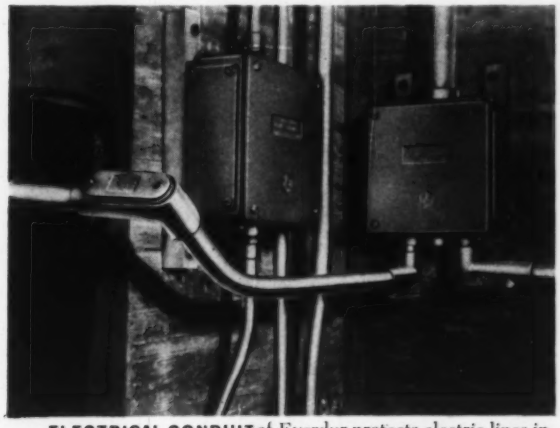
Get unusual corrosion resistance, plus high strength, toughness, weldability, and easy fabrication with Everdur,® Anaconda copper-silicon alloys



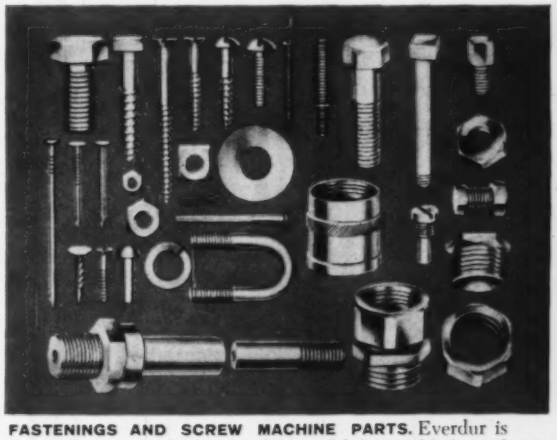
TANKS AND INDUSTRIAL EQUIPMENT requiring a combination of high strength, toughness and resistance to corrosion. Hot water storage heaters and tanks, unfired pressure vessels of Everdur are readily fabricated by welding.



IN WATER AND WASTE SYSTEMS, Everdur alloys provide easy fabrication and long service in a wide variety of jobs—from gates on to bolts and nuts. Their high strength makes possible lightweight, built-up assemblies of wrought metal.



ELECTRICAL CONDUIT of Everdur protects electric lines in corrosive environments, withstands vibration and abrasion —at oil refineries, in underwater tunnels (above), chemical plants. Made in two wall thicknesses—R.C. and E.M.T.



FASTENINGS AND SCREW MACHINE PARTS. Everdur is available in forms for hot heading and forging of bolts and accessories, severe cold-working operations for bolts and screws—and as free-cutting rod for screw machine products.

Whenever you have a tough problem calling for high strength with immunity to rust, and corrosion resistance equivalent to pure copper, consider an Everdur alloy. It may save you a lot of trouble and money. For details on properties and applications of Everdur alloys, write for Publication E-5. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5844

EVERDUR

COPPER-SILICON ALLOYS

products of

ANACONDA®

Made by The American Brass Company

ABOUT MEN AND WEAPONS

For centuries men have tried to develop new and more powerful weapons to achieve victory in war.

Lately these have been weapons of unprecedented power.

Now war can become race suicide, and victory thus gained is a delusion.

Yet we keep on trying to develop new and more powerful weapons, because we must.

Not because we seek victory through a nuclear war, but because through strength we may prevent one.

For as long as there are powerful forces with a record of cynical duplicity and oppression, the free world must have weapons capable of neutralizing them.

At least until men learn that the only alternate to peace is oblivion.

At Sandia, we play an important part in providing this protective strength. Our scientists and engineers are responsible for research, design, and development of nuclear weapons for the Atomic Energy Commission. This makes these men exceptionally valuable assets in our nation's efforts to secure the future.

We need more such men — outstanding engineers and scientists in many fields, especially at the highest academic and experience levels. At Sandia in Albuquerque and at our branch laboratory in Livermore, California, we need their knowledge, skill, and perseverance.

If you can help us meet this need, or if you know anyone who can, write Staff Employment Section 553.

SANDIA CORPORATION

ALBUQUERQUE. NEW MEXICO

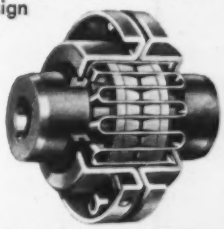
How one FALK coupling saved more than $1,000 per month

Pictured below is a Falk Steelflex Coupling assembly which connects a 2500 hp motor to a reduction unit driving an 18″ bar mill in a Midwestern steel plant. This coupling replaced another type which broke repeatedly, causing maintenance expense averaging $1,000 a month—plus costly production losses. Since installation of the Falk Coupling, with its controlled torque mechanism that disengages when a predetermined overload occurs, there has been no interruption of production. Savings in maintenance and in lost production time are well in excess of $1,000 per month...dramatic proof of the importance of coupling design!

Long coupling life is not the sole criterion of coupling performance. Inadequate shaft couplings may be the cause of bearing damage or shaft breakage on your machines. If so, a change to Falk Steelflex will give two-fold protection to your connected machines: (1) compensation for reasonable degrees of shaft misalignment, and (2) torsional resiliency to reduce peak loads as much as 30%. These advantages are as important to you as the long service life of the Falk Steelflex Coupling itself.

Falk Steelflex Couplings, in types and sizes to meet virtually all industrial applications, are promptly available from distributor, warehouse and factory stocks. Consult your Falk Representative or Authorized Falk Distributor.

Basic **Type F**—cutaway view showing exclusive grid-groove design



THE FALK STEELFLEX ...a truly flexible coupling

Here is the coupling that has all the strength of steel, yet is truly flexible. *More than a million* have been bought for industrial service of many kinds.

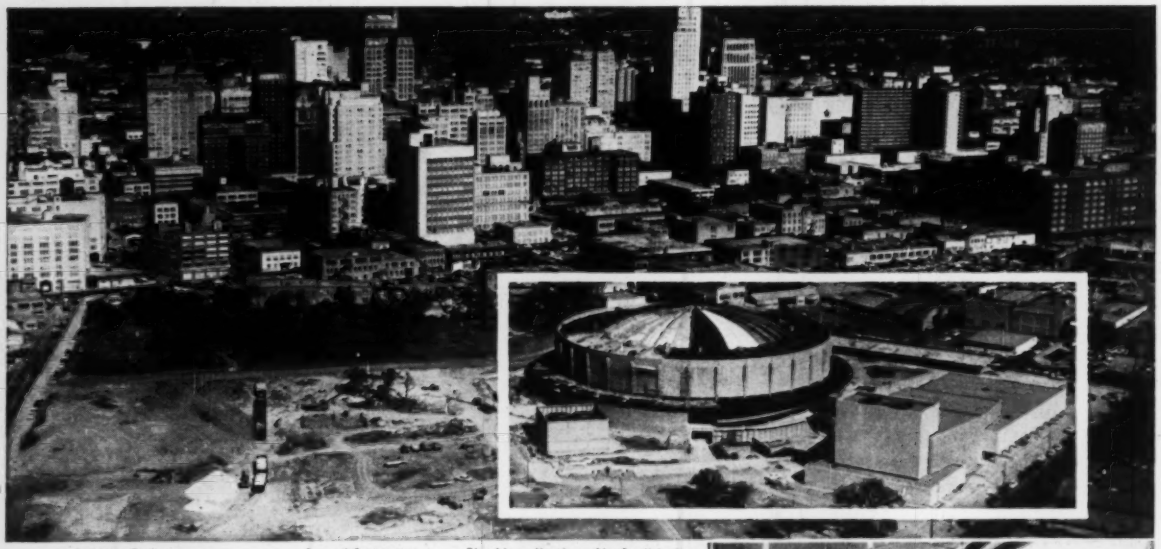
Because, in addition to its inherent superiorities of design, the Type F Steelflex can be used horizontally or vertically without modification or special parts, it has been adopted as standard in many plants—and by many designers and manufacturers of industrial equipment...Write for Bulletin 4100.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities

Good couplings not only connect machines; they prolong machine life and boost production!



Architect-Engineer
George L. Dahl Architects and Engineers
Dallas, Texas

General Contractor
R. P. Farnsworth & Co., Inc.
New Orleans, La.

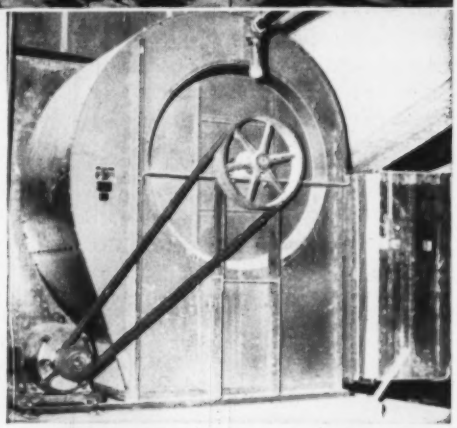
Plumbing, Heating, Air Conditioning
C. Wallace Plumbing Co., Inc.
Dallas, Texas

Another Coliseum Chooses Clarage Air Handling and Conditioning Equipment

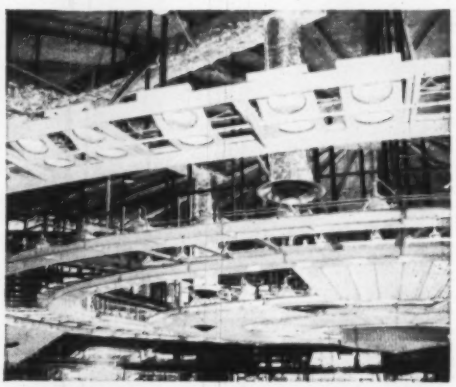
IMPRESSIVE in the Texas tradition is the new Dallas Memorial Auditorium. Its circular arena building, reportedly the largest cement domed structure in the nation, connects with a convention building and lyceum, shown on the right above.

Air handling throughout this vastness was assigned to Clarage equipment – Multitherm conditioning units, Unicoil sprayed coil units, giant system fans, ventilating sets.

Here again, as in New York's new Coliseum and other prominent buildings of all types, Clarage equipment was chosen for its recognized ability to perform quietly, economically, and dependably. CLARAGE FAN COMPANY, Kalamazoo, Mich.



One of several Clarage Type NH fans located in the outer ring which encircles the Coliseum's dome.



Arrangement of air conditioning ductwork, viewed before completion of the ceiling.

CLARAGE ... *dependable equipment for making air your servant*

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

ALLEN-BRADLEY

new

BULLETIN 350 reversing drum switch

Styled by Brooks Stevens, internationally famous industrial designer.

- *MODERN IN APPEARANCE*
- *AVAILABLE AS OILTIGHT—FOR CAVITY MOUNTING*
- *EASY TO MOUNT*
- *EASIER TO WIRE*
- *INSTANT CHANGEOVER FROM MAINTAINED TO MOMENTARY CONTACTS*

A-B QUALITY

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

6-58-MR

A new "quality" standard for small REVERSING DRUM SWITCHES

A-B QUALITY

GOOD-LOOKING AND GOOD "FEELING" DIE CAST HANDLE

EASILY ACCESSIBLE MOUNTING HOLES

MERELY LOOSEN SCREW AND SLIDE PLATE to change from momentary to maintained contacts —or vice versa

INDEPENDENT SWITCH MOUNTING prevents misalignment

HEAVY CONTACT SURFACES for long operating life

TWO CONDUIT OPENINGS

WRAP-AROUND COVER gives complete access to drum

SINGLE SCREW COVER MOUNTING —screw cannot fall out

ACCESSIBLE SCREW TERMINALS for front wiring

RAISED EDGE for base mounting without spacers

maximum rating 2 horsepower

NEW OILTIGHT COVER PLATE FOR CAVITY MOUNTING

Bulletin 350 Reversing Switch can be furnished with oiltight cover plate with rubber gasket seal for cavity mounting in a machine base.

This *all-new* Allen-Bradley reversing drum switch was designed to keep pace with the mechanical beauty designed into so many of the modern machine tools.

The Bulletin 350 reversing switch is equivalent to a three-pole, double throw switch . . . and can be used with d-c motors; or single phase, two phase, or three phase a-c motors.

Investigate the Bulletin 350 . . . the *new leader* of its class . . . in appearance, ease of installation, and operating life. An Allen-Bradley *quality* switch . . . in every sense of the word. Send for descriptive bulletin.

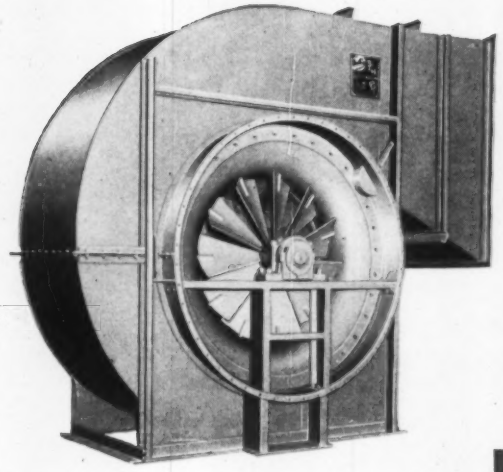
ALLEN-BRADLEY

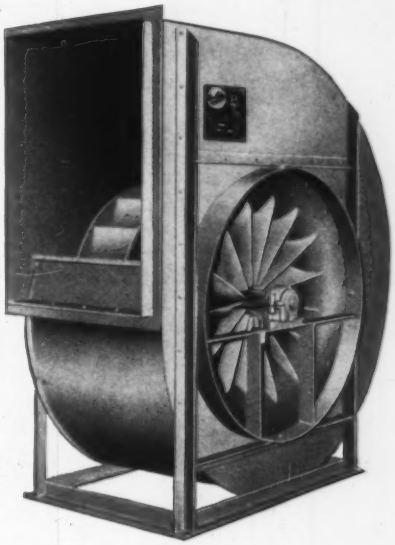
MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

6-58-MR





FAN JOBS DIFFER... *so should the fans!*

To enable you to more correctly meet varying pressure requirements, Buffalo Forge offers not just one fan design for high and low pressure but two specially designed fans. The type "BL" is for low and moderate pressure, the Type "BLH" for high pressure service. Here are the details.

FOR HIGH PRESSURES: "BUFFALO" TYPE "BLH" The "Buffalo" Type "BLH" Fan was recently designed specifically to meet Class III & IV conditions. This insures you of optimum performance on high pressure systems. The high mechanical efficiency of the "BLH" — 86% — is maintained over a broad operating range. Stability of performance is constant from free delivery to shutoff. The unique design of the "BLH" — smooth inlet bell, directional inlet vanes, backward curved blades, divergent outlet — results in unusually quiet operation. All sources of turbulence are minimized.

Investigate the "BLH" for your high pressure requirements. Consult your nearest "Buffalo" Engineering Representative, or write today for Bulletin F-200.

FOR MODERATE PRESSURES: "BUFFALO" TYPE "BL" The "Buffalo" Type "BL" Fan has won a solid reputation for efficient performance in many of the largest Class I & II installations. Non-overloading like the "BLH", the "BL" is noted for quiet, stable output from free delivery to shutoff. Unusual design features of the "BL" are responsible for its high operational efficiency. For example, minimum turbulence is assured by the smoothly curved inlet bell with directional guide vanes. Other "BL" features include the rigid wheel, tested and balanced at the factory and the correctly shaped scroll of the "wheel-suited" housing.

For peak performance on your moderate pressure systems, ask your "Buffalo" Representative about the "BL" — or write us for Bulletin F-102.

Every "Buffalo" Fan features the famous "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

BUFFALO FORGE COMPANY
BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd. • Kitchener, Ont.

"Buffalo"

VENTILATING • COOLING • HEATING • AIR TEMPERING • PRESSURE BLOWING • EXHAUSTING • FORCED DRAFT • INDUCED DRAFT • AIR CLEANING

"...AND QUIETLY BOLD"

A Message to the Scientific Community from Dr. Hugh L. Dryden, Director, NACA

NACA has pioneered in preparations for manned and unmanned space flight for the past six years and has designed and built unique aerodynamic, structural and propulsion facilities for space research. We of NACA are moving to insure that our contributions to space technology will match our record in aeronautics. It is imperative that America lead the way in the peaceful exploration of space. Our nation has the talents and resources to do the job. But we must recall the wisdom of the Killian Committee which recently said: "Let us be cautious and modest in our predictions and pronouncements about future space activities and quietly bold in our execution."

Hugh L. Dryden

Hugh L. Dryden

Hugh L. Dryden, Director, NACA; Ph.D., Johns Hopkins University

NACA has a staff of 7,750 research scientists and supporting personnel spread among its research centers on both Coasts and in Ohio. NACA staff members in pursuit of new knowledge have available the finest research facilities in the world, including several of the largest and fastest supersonic and hypersonic wind tunnels, hot jets, a fleet of full scale research airplanes, which will include the X-15, hypersonic ballistic ranges, shock tubes, a nuclear reactor establishment, rocket facilities, a research missile launching site, tracking devices, and the most advanced mechanical and electronic computers.

NACA Fields of Research Include: Analytical Dynamics, Solid State Physics, Hypersonic Aerodynamics, Magneto Hydrodynamics, Energy Sources, Propulsion Systems, Aerodynamics, Automatic Stabilization, Vehicle Configuration and Structure, Materials, Flight Simulation, Instrumentation.

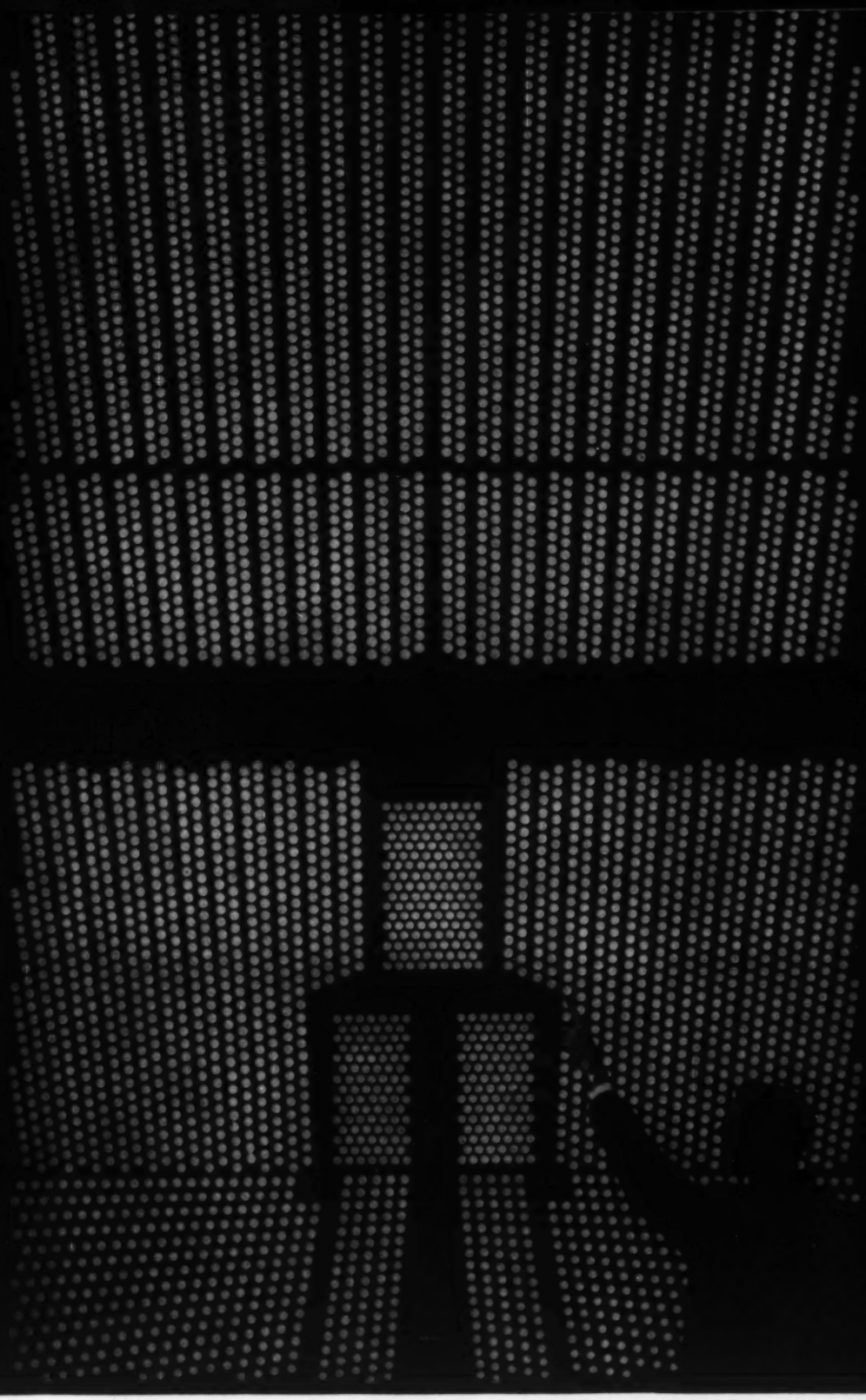
A number of staff openings are becoming available. You are invited to address an inquiry to the Personnel Director at any one or all four of the NACA research centers:

Langley Aeronautical Laboratory, Hampton, Virginia
Ames Aeronautical Laboratory, Mountain View, California
Lewis Flight Propulsion Laboratory, Cleveland, Ohio
High-Speed Flight Station, Edwards, California

(Positions are filled in accordance with the Aeronautical Research Scientist Announcement 61B)

NACA

The Nation's Aeronautical Research Establishment



This is Marind's tube layout for one bank of a two-pass, divided-flow condenser designed to operate in conjunction with a 156 MW turbo-generator. Generous inter-tube laning; ample belt-steam areaway for reheat, steam distribution and de-aeration in the "hot well"; and a compact, efficient noncondensable gas cooling section . . . are all engineered to meet the needs of a particular turbo-generator. When your plans call for steam surface condensers, take advantage of Marind's many years of engineering experience and facilities for designing and producing condensers of any size.

MARIND

MARYLAND SHIPBUILDING & DRYDOCK COMPANY • Industrial Products Division

Baltimore 3, Maryland • *Representatives in Principal Cities*

Experience**—the added alloy in **A-L Stainless, Electrical and Tool Steels

Allegheny Ludlum knows more about stainless than anybody . . . and puts it in print for you

Allegheny Ludlum *should* know more about stainless than anybody: they've been the leading producer of all forms for more than 40 years. And the industry's only that old.

Today, A-L produces more different sizes, shapes, finishes and alloys of stainless than any other company. Backing up its quality products are research and development facilities with people second to none.

With know-how and experience gained over the years, Allegheny Ludlum keeps little of it secret: it offers the most complete selection of literature available anywhere.

Literature, designed to help you learn more about Allegheny Stainless and how it can improve your product, is just one help offered by Allegheny Ludlum. You also get the best assistance from trained salesmen and technicians, ready to help you on your specific problem.

All this service is available through your Allegheny sales engineer. Call him today. Or, as a starter, write for the publication list describing the over 150 technical pieces made to assist you.

Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa. Address: Dept. ME-6.

WSW 7132

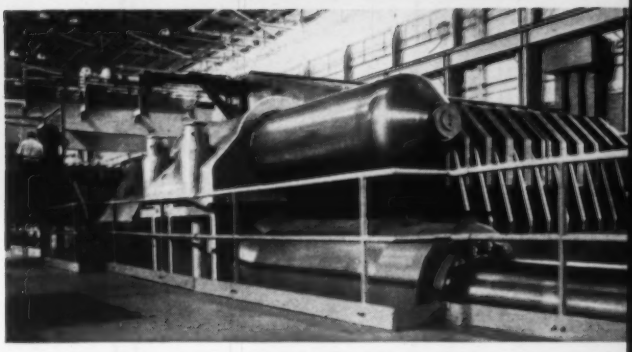
ALLEGHENY LUDLUM

for warehouse delivery of Allegheny Stainless, call RYERSON

Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

8000-ton plate stretcher-leveller as seen from the cylinder end and stationary grip head. Movable grip head is in rear.



8000-ton plate stretcher-leveller as seen from the cylinder end, operator's side.

Huge Loewy stretcher-leveller is only one in world that can handle plate up to 152 in. wide

In 1947 Loewy-Hydropress built an 825-ton-capacity stretcher-leveller for heavy plate—world's largest. Ever since, Loewy engineers have paced the field. Recently they put an 8000-ton model into operation at Alcoa's Davenport, Iowa, plant—in hardly more than a decade they had developed one 10 times as powerful as the giant of 1947. Over 160 ft. long and weighing more than 5,500,000 lb., this machine can grip in its massive jaws rolled aluminum plate up to 152 in. wide, 95 ft. long, and 6 in. thick, stretch-straightening it with a pull of 16,000,000 lb.

Loewy stretcher-levellers are pushbutton operated by one man. Uneven and severely warped plates and sheets of aluminum, carbon steel, stainless steel, nickel-clad steel, and other materials are straightened to fault-free flatness and smoothness within seconds. During stretching the material is stressed beyond its yield point. This equalizes the stress over the entire cross-section and prevents warpage and distortion during later machining operations, while simultaneously improving physical properties.

Loewy-Hydropress will build stretcher-levellers for plate and sheet and stretcher-straightener-detwisters for rod and sections in all sizes and capacities, from 100 to 8000 tons, even to much higher capacities if required.

Write us at Dept. F-6 if you would like to know more about these powerful auxiliaries to rolling mills and extrusion presses in which Loewy specializes.

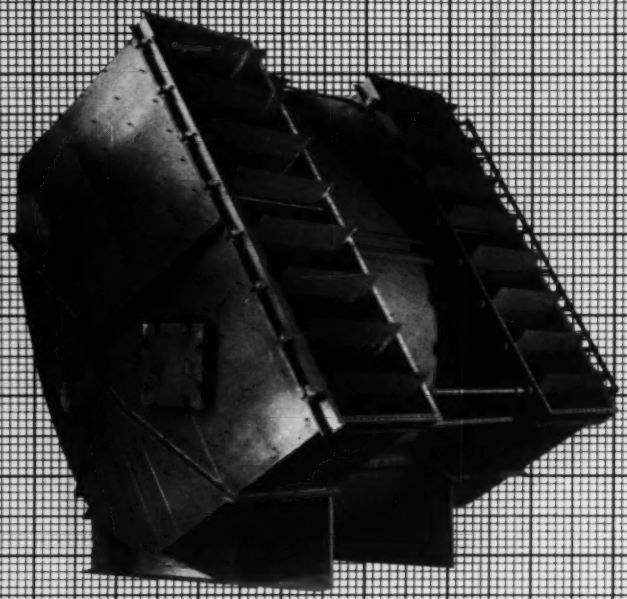
Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN BLH LIMA-HAMILTON

AMERICAN BLOWER SIROCCO FANS



HIGH STATIC EFFICIENCY
LOW INITIAL COST
SMALL FLOOR SPACE

LOW RPM • LONGER LIFE
LOW WR²

INDUCED AND FORCED DRAFT FOR BALANCED DRAFT OR PRESSURIZED BOILERS • DOUBLE AND SINGLE INLET

Look for low initial cost, reduced operating costs, guaranteed performance ratings, minimum maintenance and space requirements. You'll find them *all* in American Blower Sirocco mechanical draft fans.

Specially designed for induced-draft and forced-draft work, Sirocco Fans feature die-formed, forwardly inclined blades for high static efficiency at low rpm's. Streamline, low-turbulence inlets also contribute to high efficiency. And for longer service life, Sirocco Fans have heavy-duty rim and hub plate construction . . . heavy, steel-plate housings and inlets. Special erosion-resistant features are available, as well.

For high efficiency, low cost over the entire operating range, couple Sirocco Fans with American Blower *Gyrol*® Fluid Drive. Infinitely variable in speed, Gyrol Fluid Drive matches fan speed to boiler demand; pays off in longer life for fan wheels and bearings; quieter operation.

If you are investigating mechanical-draft equipment for new or existing installations, take advantage of our experience in air handling. Call your nearby American Blower branch office, today. Or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

American-Standard Products

AMERICAN-Standard

AMERICAN BLOWER DIVISION

Twin-shell, triple-lane, single-pass Condenser with 187,000 sq. ft. capacity. One of largest units ever built, it was recently installed at large eastern utility.

In tube layout, too... design makes the difference with C. H. Wheeler condensers

You see here one of the many reasons why C. H. Wheeler Dual Bank Surface Condensers operate so efficiently in scores of public utilities and industrial plants throughout the country.

Triple Lane Tube Layout, with three separate pathways for steam travel, allows the steam to penetrate to the peripheries of all tubes.*

Design like this, typical of C. H. Wheeler engineering, steps up condenser efficiency. Other engineering advancements—such as patented Reverse Flow, which permits flushing away leaves, twigs, algae and other foreign matter—reduce maintenance requirements. "Zero" condensate temperature depression, pure condensate and deaeration to 0.03 cc. of oxygen per liter (special design provides for deaeration to 0.01 cc. of oxygen per liter) . . . are additional features you get with C. H. Wheeler Condensers.

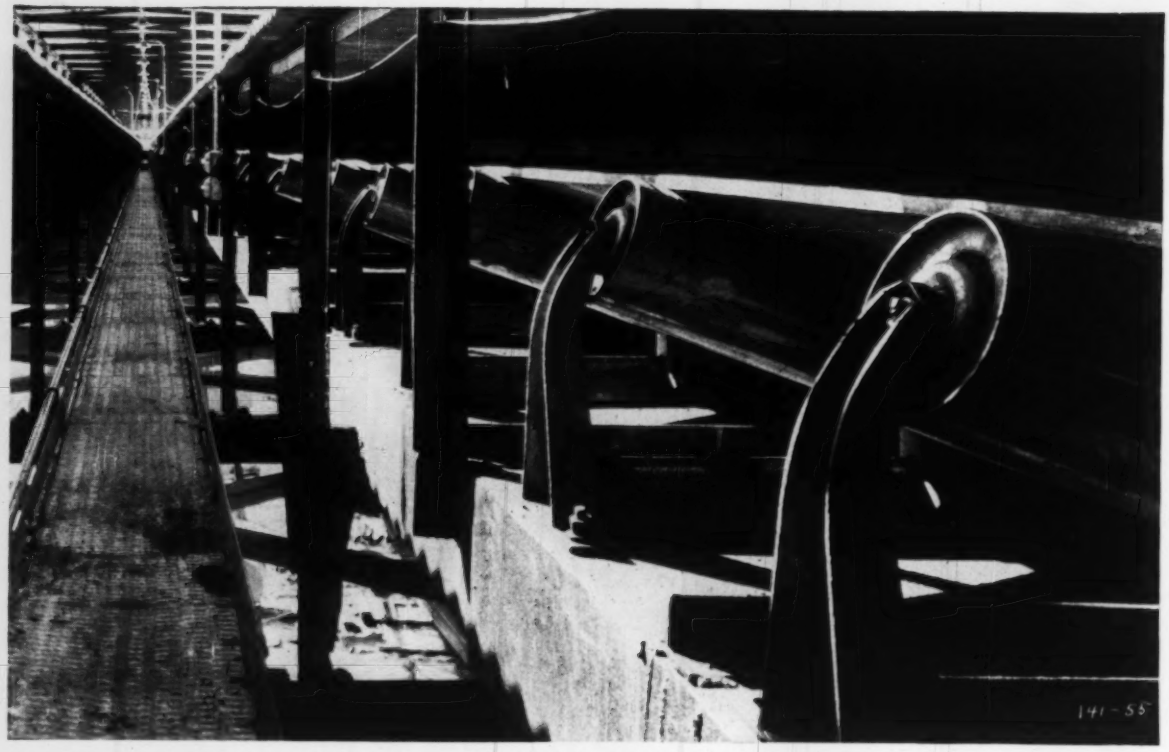
Location of the air-vapor take-off reduces the resistance to steam passage. This minimizes the depth of steam penetration through the tube bank of all C. H. Wheeler Condensers.

C. H. WHEELER MFG. CO.

19th and Lehigh Avenue • Philadelphia 32, Pennsylvania

Whenever you see the name C. H. Wheeler on a product, you know it's a quality product

Steam Condensers • Steam Jet Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products

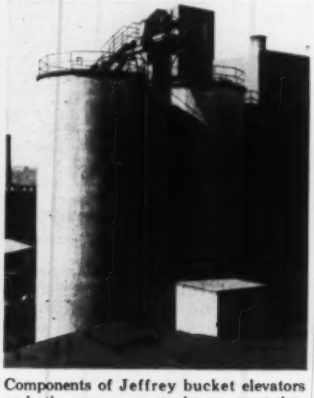


Automate your materials handling...
with **Jeffrey** *equipment*

Efficient, dependable Jeffrey conveying equipment is a valuable antidote for rising costs in processes where bulk materials must be moved. PERMASEAL® idlers on these conveyors mean years of usage without greasing—contribute to lower operating and maintenance costs.

Jeffrey products are available through distributors in principal cities. You'll find these men *production-conscious*, ready and willing to advise on your conveying needs. For this help, see them or write The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

Jeffrey spiral conveyors are available in many styles for moving dry, bulk materials. Compact, they occupy minimum space. Convenient, they can be fed or discharged at any point along their length.



Components of Jeffrey bucket elevators and other conveyors can be constructed to withstand corrosive attack, assuring long life and safeguarding materials handled.

For in-plant conveying or for belts extending across country, Jeffrey PERMASEAL® idlers offer every feature essential to belt protection, dependability and long service.

CONVEYING • PROCESSING • MINING EQUIPMENT . . . TRANSMISSION MACHINERY . . . CONTRACT MANUFACTURING

JEFFREY

seals tight

without valve damage

How you cut costs with the new

TUBE-TURN LIGHT WEIGHT TAPER FACE FLANGES

The new TUBE-TURN* 125 lb. light weight, forged steel, taper face welding neck flanges (patent pending) can cut costs three ways:

1. You eliminate the hazard of breaking cast iron and semi-steel valves, fittings and equipment such as pumps and compressors, caused by overstressing the bolts to get a tight seal when regular ASA steel flanges are used.
2. You avoid the necessity of using more expensive 250 lb. valves with 300 lb. companion flanges.
3. The new flanges cost less, weigh less and take less storage space than the 150 lb. flanges they replace.

Maximum service pressures are the same as for Class 125 cast iron flanges in ASA B16.1, namely: 125 psi (gage) saturated steam; 175 psi (gage) liquid and gas (WOG) at 150°F.

Here is another example of the cost-saving advantages you realize when you specify TUBE-TURN products and buy them from your nearby Tube Turns' Distributor.

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

tt TUBE-TURN

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

For more details, turn the page

The trademarks "TUBE-TURN" and "tt" are applicable only to the quality products of Tube Turns.

How TUBE-TURN®

Taper Face Flanges give you a

tighter seal

without overstressing

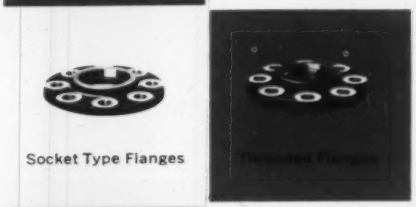
TUBE-TURN taper face forged steel welding neck flanges conform to the 150 lb. American Standard with respect to flange diameter and drilling, but both the flange ring and tapered hub are thinned to make them compatible in strength and stiffness to Class 125 American Standard cast iron flanges with which they are mated.

In addition, the flange face has a 1½° convex taper which concentrates gasket contact pressure near the bore, reducing the required sealing force. As the bolts are tightened—but long before the bolt moment becomes excessive—the flexible steel flange is deflected toward the cast iron flange to the extent that contact is established over the entire gasket face.

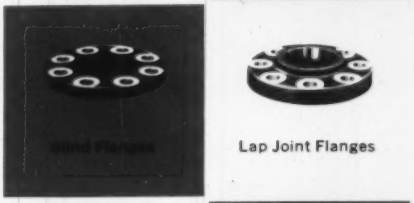
Thus, these features combine two important advantages: (1) A lower sealing force associated with minimum width ring gaskets, located at the bore; and (2) assurance against over-tightening which is characteristic of full face gaskets.

*"TUBE-TURN" and "®" Reg. U. S. Pat. Off.

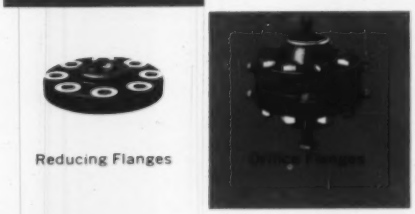
Slip-on Flanges



Socket Type Flanges



Lap Joint Flanges



Reducing Flanges

There is a complete line of TUBE-TURN Flanges.

Using TUBE-TURN Taper Face Flange on gas distribution line.

TUBE-TURN large diameter ASA Type and pressure vessel flanges.

Your nearby Tube Turns' Distributor provides a complete line of TUBE-TURN Flanges. This one source for all your needs in welding fittings and flanges (more than 12,000 items) enables you to put all your requirements on one order . . . to cut red tape and save purchasing time.

MAIL FOR WALL CHART

TUBE TURNS
224 East Broadway, Louisville 1, Kentucky

Please send free Flange Matching Chart.

Company Name _____

Company Address _____

Your Name _____

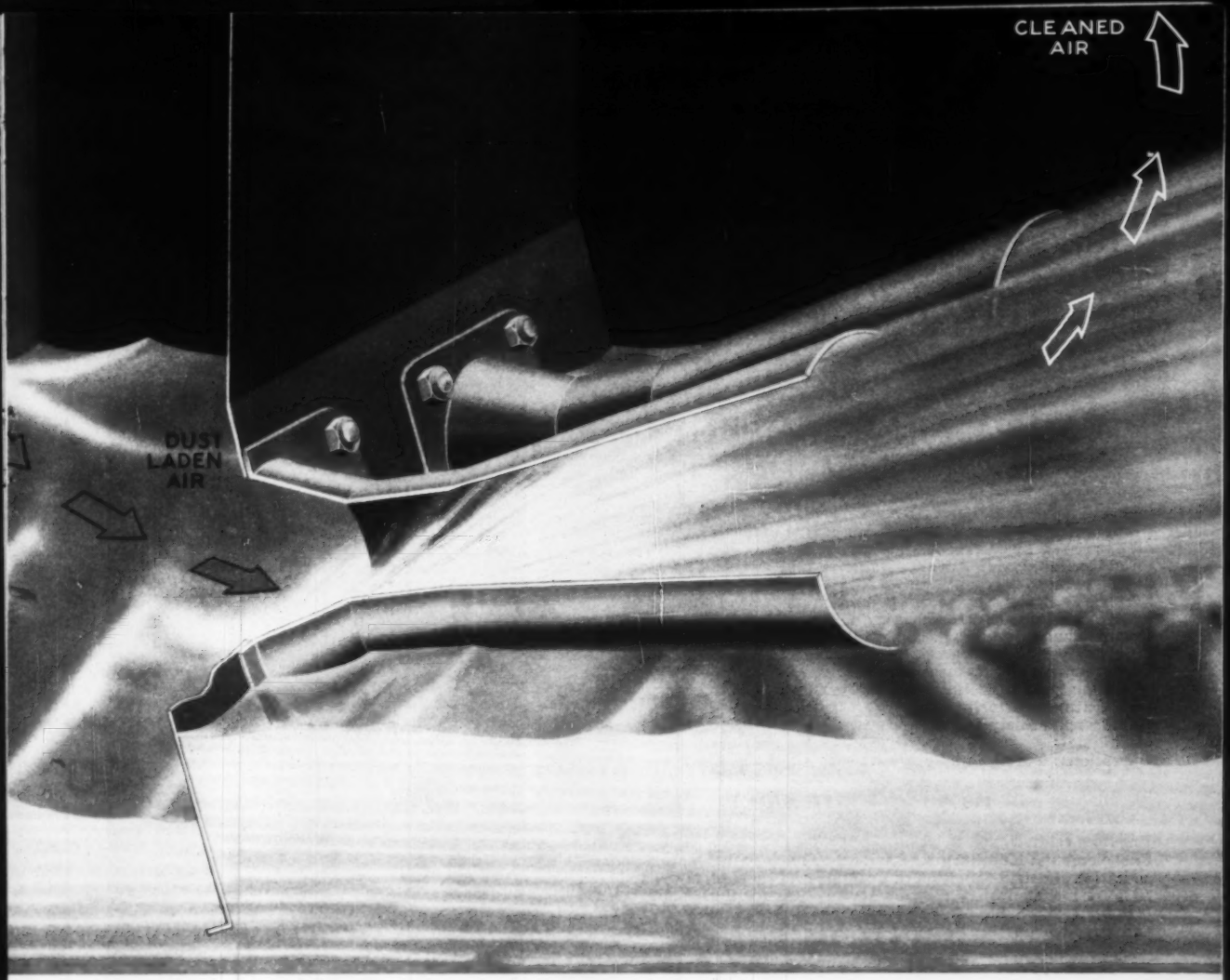
Position _____

City _____ *Zone* ____ *State* _____

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland • Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle. **IN CANADA:** Tube Turns of Canada Ltd., Ridgetown, Ontario • Toronto, Ontario • Edmonton, Alberta • Montreal, Quebec • Vancouver, British Columbia.



Puts the squeeze on difficult dusts

Pangborn Ventrijet Wet Dust Collector uses exclusive venturi tubes for peak efficiency

Pangborn Ventrijet Wet Dust Collector on the job. This is just one of Pangborn's comprehensive line of wet and dry dust collectors.

That pinch-necked venturi tube is the secret behind Pangborn Ventrijet performance. As dust-laden air flows through these tubes, the constriction creates a low-pressure area which draws water into the air stream. The resulting turbulence breaks the water into particles which actually *wash* the dust from the air. The simplicity of Ventrijet design saves money in its ease of installation, its low cost of operation and maintenance.

Although the Ventrijet is particularly suited to collecting hot, moist, inflammable, corrosive and obnoxious dusts, the Pangborn engineering it typifies is important to *any* dust-producing plant. It is not enough to put a dust collector within a plant. An efficient dust control system must be *scientifically* planned, designed and constructed to handle effectively a specific dust problem. This thinking is incorporated into every Pangborn proposal.

The Pangborn Engineer in your area will be glad to go to work for you. He is a dust expert *and will discuss your individual problem at no obligation. And, for more information, write for Bulletin 922 to:* Pangborn Corp., *2200 Pangborn Blvd., Hagerstown, Md. Manufacturers of Dust Control and Blast Cleaning Equipment.*

Pangborn CONTROLS DUST

leading reactor builder offers

LONG RANGE CAREERS

in worldwide nuclear projects

EXPERIENCED NUCLEAR ENGINEERS

ANALYTICAL

Degree essential. Experience as required.
Preliminary analysis: Conduct preliminary analysis and design of overall power reactor systems and components.
Shielding analysis: Advanced studies and analysis on stationary and mobile plants.
Systems analysis: Engineering direction on reactor plant design.
Control analysis: Reactor kinetic and overall nuclear power plant control. Hazard analysis. Analog and digital computers.
Core analysis: Includes criticality, temperature, void and power coefficients, control effectiveness and fuel cycles.
Stress analysis: Structural, thermal, and dynamic stress analysis of high temperature reactor systems.
Heat transfer analysis: Reactor systems – dynamics and thermo-dynamics of fluid flow.
Operations: Foreign and domestic – for checkout, start-up and training.

DEVELOPMENTAL

Requires related experience and applicable degree.
Fuel elements: Metallurgists for R&D on nuclear fuel materials, including radiation effects, evaluation of uranium and thorium alloy, and ceramics. Also for mechanical fabrication development for these materials.
Instrumentation and control: Experienced physicists and EE's for design and development of advanced design vacuum tube, transistor, and/or magnetic amplifier control and instrumentation components. Design and analysis on reactor control systems, using stability and transient response techniques.
Nuclear fuel reprocessing: Inorganic and physical chemists for developmental studies and experimental work. Experience with radioactive materials and high temperature processes desirable.

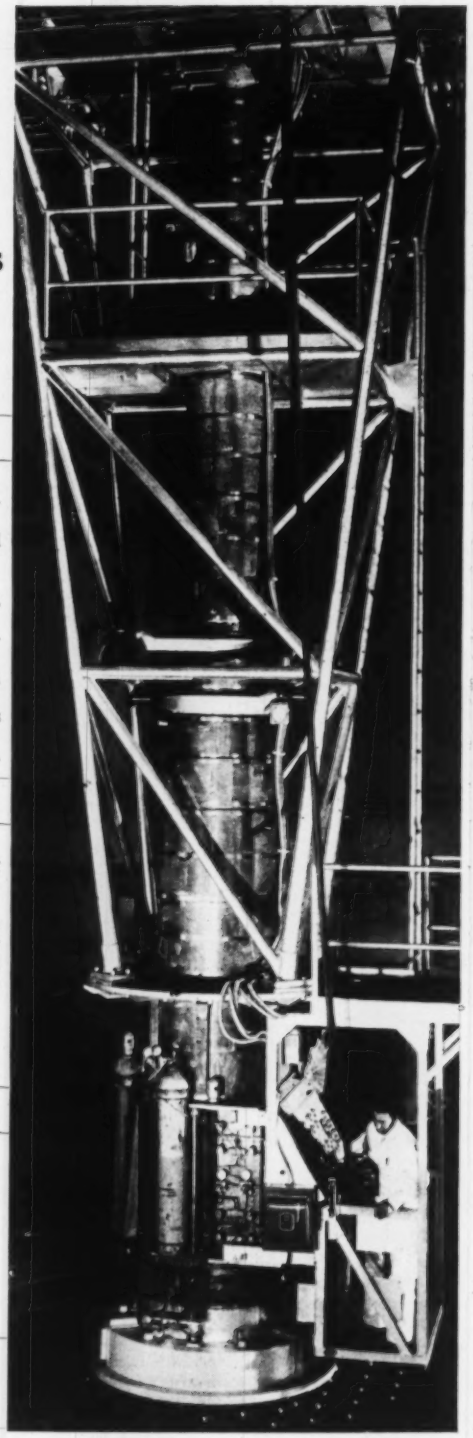
DESIGN

Senior openings. Degree required. Nuclear experience essential.
Control mechanisms: Control and safety rods, drives and allied tooling.
Reactor core components: Moderator cans, fuel elements, core supporting structures.
Machine design: Heavy mechanical.
Electrical: Reactor control and power systems.
Process systems and equipment: Pumps, Heat transfer equipment.
Facilities: Mechanical systems.
Process instrumentation: Reactor, auxiliary, and control systems.

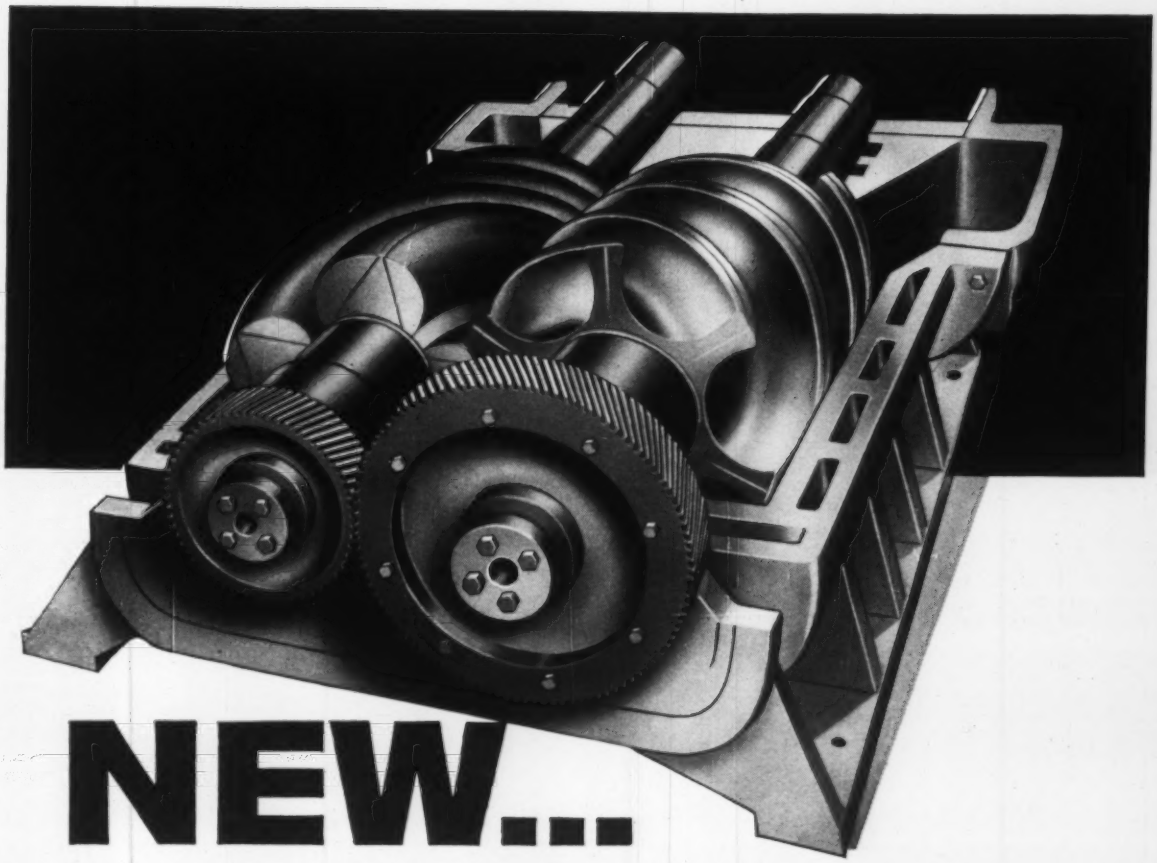
Other opportunities in:
Theoretical, Experimental, Solid State Physics, Health Physics, Materials Research, Mechanical Component Development.

Write for more details of exciting career opportunities at AI.
Mr. A. F. Newton, Personnel Office, Atomics International
15330 Raymer Street, Van Nuys, California
(In the suburban San Fernando Valley, near Los Angeles)

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM



SRE Fuel Handling Cask. The Sodium Reactor Experiment and the Organic Moderated Reactor Experiment are both in successful operation. Plans for several central station plants based on these experimental power reactors are underway. AI is also conducting an advanced power reactor study for Southwest Atomic Energy Associates. Overseas, AI has already sold 5 reactors, and is affiliated with ASEA of Sweden and the new company INTERATOM (with DEMAG, West Germany).



NEW...

Fairbanks-Morse Positive Displacement Axial-Flow Rotary Compressor

Combines the best features of reciprocating and centrifugal compressors

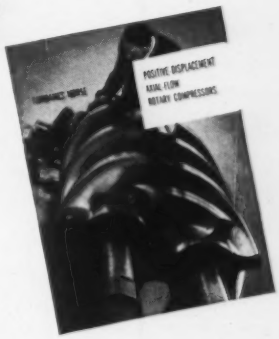
Consider the advantages of the all-new Fairbanks-Morse two-impeller, helical-lobe type, axial-flow rotary compressor:

1 Delivers oil-free air or gas with low ratios of unit weight and space to capacity.

2 Exhibits high efficiencies and positive-displacement stability of flow at varying compression ratios and speeds.

Result: Ideal performance from a relatively small compressor that is mechanically simple, flexible in application, adaptable to any power source; a compressor that provides stable performance, smooth operation, and variable-capacity control.

This all-new F-M Compressor is available in 5 standard case and impeller sizes, single-stage and multi-stage units—for pressure, vacuum or booster service. Capacities range from 800 to 13,000 cfm.—also higher or lower if desired, on custom-designed basis. Contact your Fairbanks-Morse branch for further information, or write directly to Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Illinois.



Ask for new illustrated bulletin ACO 100.1 giving typical performance characteristics and other important data.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

COMPRESSORS • ELECTRICAL MACHINERY • DIESEL AND DUAL FUEL ENGINES • DIESEL LOCOMOTIVES • RAIL CARS • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • MAGNETOS

STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

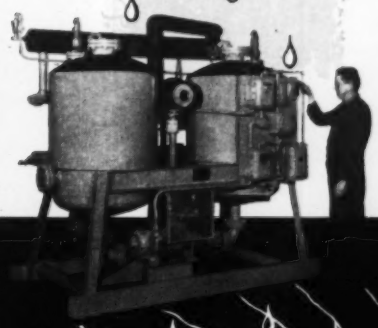
I'm sure you've heard about Douglas projects like Thor, Nike-Ajax, Nike-Hercules, Nike-Zeus, Honest John, Genie and Sparrow. While these are among the most important defense programs in our nation today, future planning is moving into even more stimulating areas.

Working as we are on the problems of space flight and at the very borderline of the unknown, engineering excellence in all fields is essential. For you engineers who can help us move forward, opportunities are almost as limitless as space itself.

If you thrive on tough problems – and there are many – we'd like to discuss a future at Douglas with you.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box K-620
Santa Monica, California

How to get more for your drying dollar

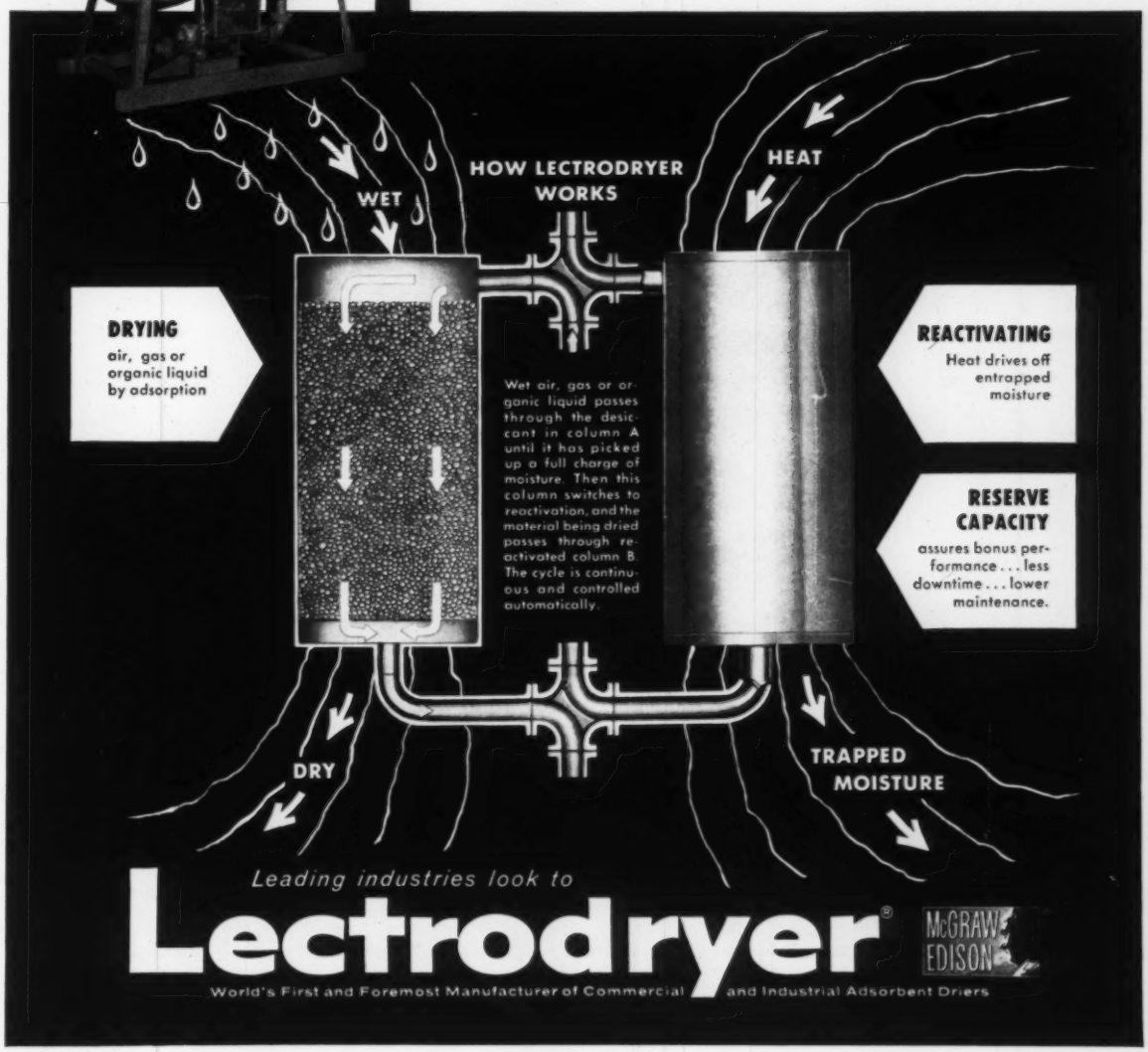


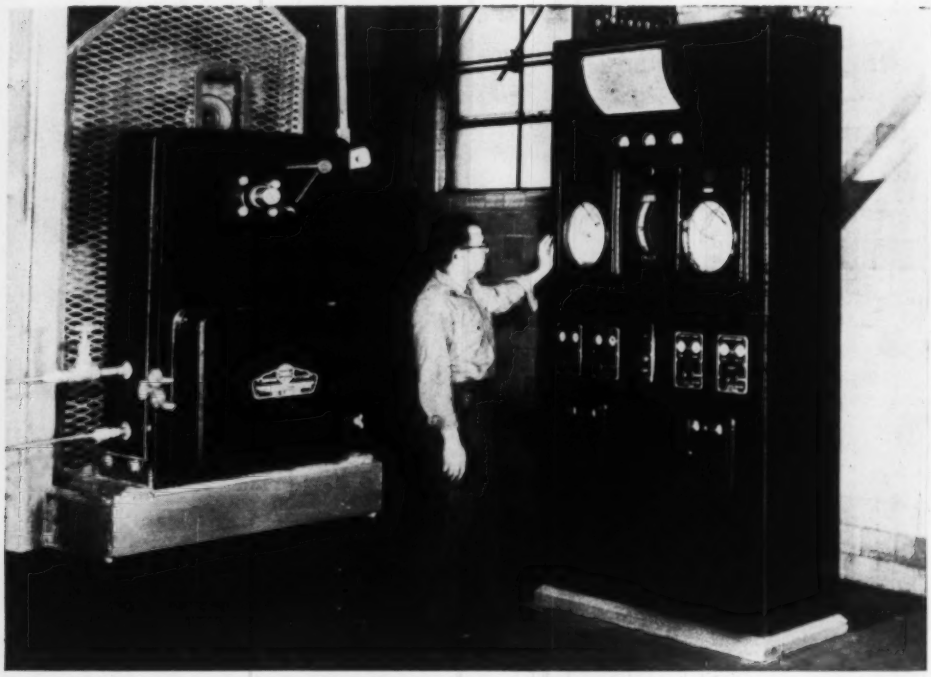
Type BY Lectrodryer for instrument air.

USERS REPORT that Lectrodryer's reserve capacity —in excess of rated output—helps meet normal production growth over the years with no reduction in drying efficiency. The liberal design and rugged construction of Lectrodryers cut downtime and maintenance costs to rock bottom . . . assure sustained, trouble-free, low-cost drying.

Leading industries look to Lectrodryer for better drying because they have found that our high performance standards result in more efficient, more profitable drying operations.

Our engineers will gladly help you solve your drying problems. Write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 335 32nd Street, Pittsburgh 30, Pennsylvania.


HOW LECTRODRYER WORKS
WET
HEAT
DRYING
air, gas or organic liquid by adsorption
Wet air, gas or organic liquid passes through the desiccant in column A until it has picked up a full charge of moisture. Then this column switches to reactivation, and the material being dried passes through reactivated column B. The cycle is continuous and controlled automatically.
REACTIVATING
Heat drives off entrapped moisture
RESERVE CAPACITY
assures bonus performance . . . less downtime . . . lower maintenance.
DRY
TRAPPED MOISTURE
Leading industries look to
Lectrodryer®
McGRAW EDISON
World's First and Foremost Manufacturer of Commercial and Industrial Adsorbent Driers



This Bailey Control System helps cut fuel costs on a 70,000 lb per hr capacity 125 psi boiler in an industrial plant. Control drive in foreground regulates stoker.

How Bailey stretches your fuel dollar...

You can wring more energy out of a dollar's worth of fuel when you are getting optimum performance from your steam plant equipment. You get peak performance when Bailey Meters and Controls are on the job. They increase your plant efficiency.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering control on your steam plant control problems.

A132-1

BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

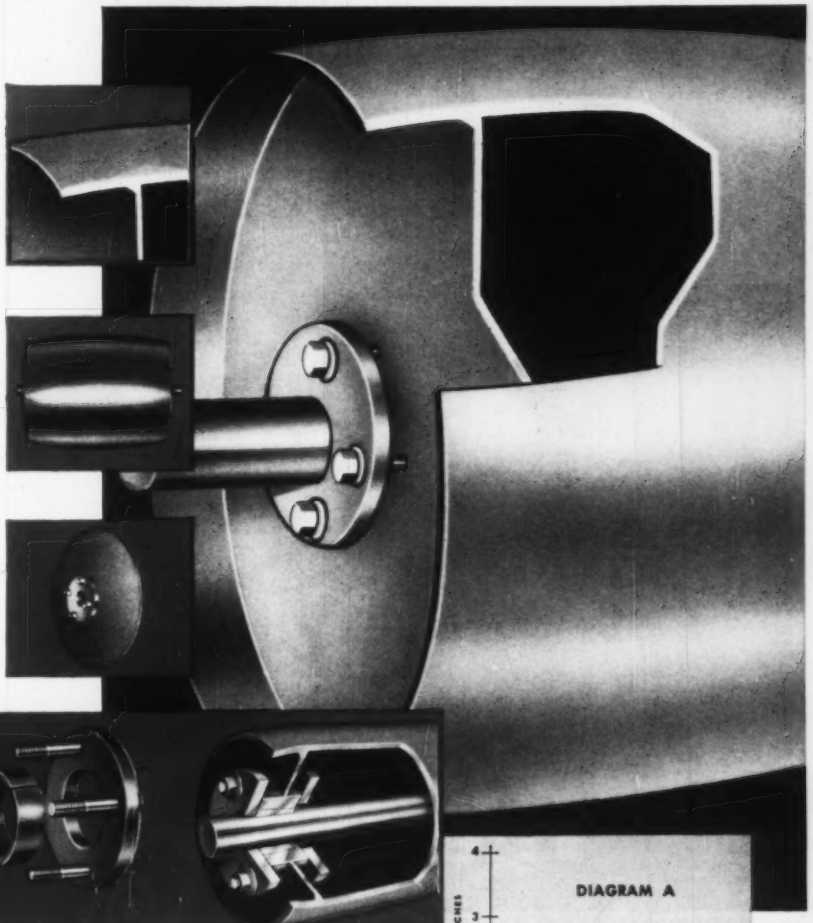
1026 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

STEPHENS-ADAMSON WELDED ALL-STEEL PULLEYS

CURVE CROWN BY STEPHENS-ADAMSON

FEATURING "SQUEEZELOCK" HUB DESIGN



CURVE CROWN* DESIGN

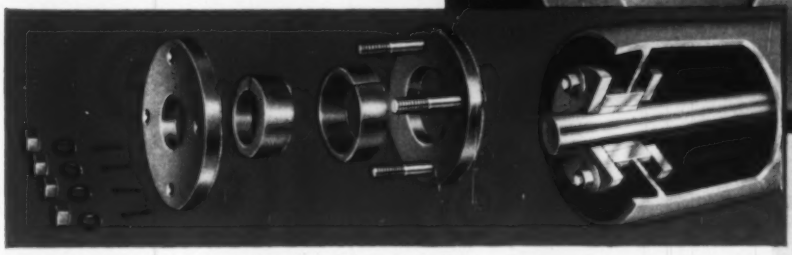
Curve crown on outer ends of rim accurately formed. Revolutionary design eliminates conventional center peak — high point for belt stretch and wear — while increasing belt training effect more than 100%. See diagram (A).

STURDY RIM CONSTRUCTION

Pulley rims are made of one-piece construction, formed absolutely round under hydrostatic pressure. The only seam is machine-welded both inside and out to insure 100% penetration of welds.

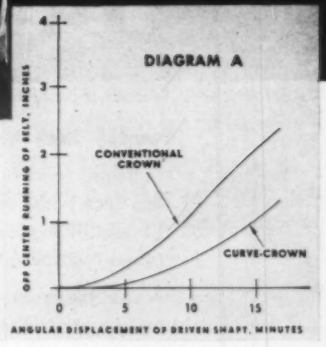
ACCURATE END PLATE ASSEMBLY

End plates are machined on both the O.D. and I.D. to insure concentricity between the bore and the outer rim. They are pressed into position for tight fit-up and submerged arc-welded for maximum efficiency.



"SQUEEZELOCK" HUB

Revolutionary design of "Squeezelock" Hub provides gripping power for full torque transmission without the use of keyways and eliminates distorting loads against pulley end plates. Two split tapered bushings are wedged against shaft and pulley end plates by two independent hub plates which are squeezed together by tightening four large diameter bolts.



WRITE TODAY FOR BULLETIN 558

*PATENT APPLIED FOR

STANDARD PRODUCTS DIVISION

STEPHENS-ADAMSON MFG. CO.

GENERAL OFFICE AND PLANT: 19 RIDGEWAY AVENUE • AURORA, ILLINOIS

PLANTS AT: CLARKSDALE, MISSISSIPPI • LOS ANGELES, CALIFORNIA • BELLEVILLE, ONTARIO

Westinghouse Order of Merit to: **J. C. RENGEL,** for outstanding leadership in the development and construction of the world's first full-scale nuclear power plant at Shippingport, Pa. devoted exclusively to the generation of electricity.

Westinghouse Order of Merit to: **A. SQUIRE,** for technical leadership and management ability in the development of submarine nuclear propulsion plants for fleet-type submarines such as the U.S.S. SKATE, nation's third atomic powered submarine.

Westinghouse Order of Merit to: **W. R. ELLIS,** for coordination and leadership in designing the Shippingport nuclear power plant.

Westinghouse Order of Merit to: **W. H. HAMILTON,** for contributions to the design and development of control systems for the first nuclear powered submarine, the U.S.S. NAUTILUS.

Westinghouse Order of Merit to: **N. J. PALLADINO,** for leadership and technical direction in the development of reactor designs for the prototype of the NAUTILUS, the NAUTILUS and the Shippingport Atomic Power Station.

Westinghouse Order of Merit to: **L. B. KRAMER,** for contributions in developing techniques and equipment for nuclear core inspection and for leadership in designing the reactor for the first fleet-type nuclear submarine, U.S.S. SKATE.

(L. to R.) J. C. Rengel, W. R. Ellis, President Mark W. Cresap Jr., N. J. Palladino, L. B. Kramer, A. Squire, and W. H. Hamilton

will be Your Colleagues at Bettis

In the ten short years since Bettis Atomic Power Division was organized, a great deal of knowledge has been gathered and put to use. This accomplishment was made possible because of the efforts of outstanding scientists and engineers, like the six men pictured above. It is due to such men and many others like them, that Bettis has established itself as the world leader in nuclear power.

And as the broad horizon of nuclear technology stretches wider with each new development, there is an urgent need for more men . . . men with the intellectual and creative ability to advance the future of nuclear power. If you have a degree in Physics, Mathematics, Metallurgy, or Engineering and are a U.S. Citizen, send your resume to: Mr. M. J. Downey, Dept. #A-51, Bettis Atomic Power Division, Westinghouse Electric Corp., P.O. Box 1468, Pittsburgh 30, Pa.

BETTIS ATOMIC POWER DIVISION

Westinghouse

BETTER YOUR FUTURE AT BETTIS

'59

Set your sights on '59 to increase your sales

Show your products to a concentrated buying audience

at the

23rd National Exposition of Power & Mechanical Engineering

auspices of ASME

New York Coliseum • December 1-5, 1958

28,636 interested buyers attended the 1956 exposition. Write today for a detailed analysis of this attendance.

With a display at the Power Show you reach important buying influences—when they're most receptive. In five short days you can achieve sales results which would ordinarily take months of effort. And do it at less cost.

The executives, engineers, and operating people who *regularly* attend the Power Show, come seeking new ideas to cut costs, boost plant efficiency. They are *looking* for new products, new applications. They come to be sold.

This year's special section on atomic products provides a perfect showcase in which you can establish your company as a contributor to this vital, expanding field.

So plan *now* to make the Power Show part of your 1959 marketing program. Write for floor plans and full details.

23rd National Exposition of Power & Mechanical Engineering

480 Lexington Avenue, New York 17, N. Y.

Management: International Exposition Company

Extensively used in the rocket and missile industry—

Here are precision products for a precision industry ... Marsh products that are *fully approved* and widely used thoughout the aircraft and missile industry:

PRESSURE GAUGES

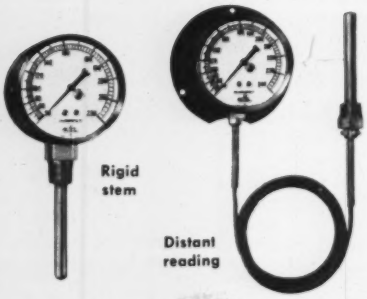
The Marsh "Mastergauge"

Accepted throughout industry as "the standard of accuracy," Marsh Gauges are the final solution to your most difficult and exacting problems. Recent Marsh developments are: Fusing of socket and bourdon tube into one-piece leak-proof unit by Marsh "Conoweld" process; "Marshalloy" case, lighter, stronger, more corrosion resistant; finer movements, safety cases, and many other unduplicated features. All Marsh Gauges are available with the Marsh "Recalibrator." There is a Marsh Gauge for practically every conceivable purpose—pressure, vacuum, compound.

NEEDLE THROTTLING VALVES

In the Marsh Needle Valve you have the answer to your need for a valve giving micrometer throttling and positive shut-off at *high* pressures—any pressure up to 10,000 psi—with equally precise regulation at any lower pressure. Today they are available in 416 stainless steel throughout with "Teflon" packing which is unimpaired by the most powerful solvents, acids and alkalies, even at temperatures up to 500° F. Suitable for oxygen, helium and high pressure air. Available in panel mounted pattern.

DIAL THERMOMETERS



Rigid stem

Distant reading

The most versatile and accurate type of bourdon tube thermometer has been brought to its highest development in the broad, highly adaptable Marsh line. Accurate readings, even when the dial is located far from the point of measurement, is assured by the vapor tension principle. The Marsh line is a complete line—wide temperature ranges; many dial sizes; case patterns; finishes. All have the famous Marsh "Recalibrator"—handiest and best way to keep an instrument accurate.

Up to the minute facts on all Marsh products are yours for the asking.

All Marsh products available with AND threads

New Catalog Covers all details

MARSH

THERMOMETERS • GAUGES • VALVES

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.,* **Dept. 29, Skokie, Ill.**
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Can.
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

HERE'S A
SPECIAL ADVANTAGE
OF THE
LJUNGSTROM:®
high availability
These five basic factors assure you that the Ljungstrom Air Preheater will give exceptionally long periods of uninterrupted availability:
1. UNIFORMLY HIGHER COLD-END METAL TEMPERATURES. This minimizes the danger of local corrosion due to cold spots.
2. POSITIVE CLEANING ACTION. A mass-flow soot blower is normally installed at the cold end of the Ljungstrom where deposits are most apt to accumulate. Daily cleaning with superheated steam or compressed air removes any deposits.
3. INSPECTION PORTS. You can see for yourself, at any time, the condition of the heating surfaces.
4. REVERSIBLE COLD-END BASKETS. Elements in the cold end are separated into small baskets, which can be inverted when one end starts to wear thin. These baskets are easy to replace, too.
5. SELECT MATERIALS FOR HEATING SURFACES. Constant research determines the material best able to withstand service conditions. For example, the cold-end elements are made of a special alloy and of a heavier gauge than the hot-end elements.
For the full story on how high-availability is built into every Ljungstrom, write for our 38-page manual.
The Air Preheater Corporation

For your use — ASME TRANSACTIONS for 1957

AERODYNAMICS
A New Approach to the Theory of Thin, Slightly Cambered Profiles.
Problems Encountered in Translation of Compressor Performance From One Gas to Another.

AIRCRAFT
Experiments With Optimalizing Controls Applied to Rapid Control of Engine Pressures With High-Amplitude Noise Signals.
Application of a New Structural Index to Compare Titanium Alloys With Other Materials in Airframe Structures.
Optional Stresses of Structural Elements at Elevated Temperatures.
Thermostructural Efficiencies of Compression Elements and Materials.
Weight-Efficiency Analysis of Thin-Wing Construction.
Design Criteria for Heated Aircraft Structures.
Discussion on Safety-Factor Requirements for Supersonic Aircraft Structures.
Some Structural Penalties Associated With Thermal Flight.
Aircraft Structural Testing Techniques at Elevated Temperatures.
Some NACA Research on Effect of Transient Heating on Aircraft Structures.
Description and Prediction of Human Response to Aircraft Thermal Environments.
Comparison of Hydraulic and Pneumatic Accessory Power Generation.
Mass Flowmeter for In-Flight Refueling.
Utilization of Solar Furnaces in High-Temperature Research.
Oronite High Temperature Hydraulic Fluids 8200 and 8515.
Experiments With Optimalizing Controls Applied to Rapid Control of Engine Pressures With High-Amplitude Noise Signals.

ALUMINUM AND ALUMINUM ALLOYS
Residual Stresses in Cold Extruded Aluminum.
Forces and Power Required to Turn Aluminum and Seven Alloys.

AUTOMATIC CONTROL
Physical and Mathematical Mechanisms of Instability in Nonlinear Automatic Control Systems.
A Graphical Method for the Analysis of Piecewise Linear Control Systems, With Particular Application to Relay Controls.
Information Center With Automatic Logger and Scanner-Neches Power Station, Gulf States Utilities Company.
Signal Stabilization of a Control System.

BEAMS
Curved Beams With Eccentric Boundaries.
Structural Damping of a Simple Built-Up Beam.
Response of Beams and Plates to Random Loads.
Beams of Uniform Strength Subjected to Bending.
Numerical Procedure for Calculating Large Deflections of Beams.
Antisymmetric Vibrations of a Beam.
Dynamic Response of Beams and Plates to Rapid Heating.
Specific Damping Energy of Fixed-Fixed Beam Specimens.
Study of Propagation of Flexural Waves.
Interaction Curves for Shear and Bending of Plastic Beams.
Stresses in Short Beams Under Central Impact.

BEARINGS, LUBRICANTS, AND LUBRICATION
Design Study of a Hydrostatic Gas Bearing With Inherent Orifice Compensation.
The Maximum Temperature Profile in Journal Bearings.
Temperature Distribution in the Journal-Bearing Lubricant Film.
The Spring-Supported Thrust Bearing.
Properties of Misaligned Journal Bearings.
Analysis of Journal Bearings With Arbitrary Load Vector.
The Fluid Dynamic Theory of Gas-Lubricated Bearings.
Heat-Transfer Effects in Hydrostatic Thrust-Bearing Lubrication.
On the Theory of Grease-Lubricated Thrust Bearings.
Predominant-Peak Surface Roughness, a Criterion for Minimum Hydrodynamic Oil-Film Thickness of Short Journal Bearings.
Statistical Analysis of a Wear Process.
Testing Dynamically Loaded Bearings - Parts I and II.
Universal Bearing Tester.
Effect of Lubricant Inertia in Journal-Bearing Lubrication.

BUCKLING
Buckling of Initially Imperfect Cylindrical Shells.
Collapse Strength of Redundant Beams.
Buckling of Thin Cylindrical Shell Under Hoop Stresses.
Buckling of Struts on Thin Plate.
Buckling of Rectangular Plates With Two Unsupported Edges
Asymmetrical Bending and Buckling of Thin Conical Shells.

COMBUSTION
Applications of an Enthalpy-Fuel/Air Ratio Diagram to "First Law" Combustion Problems.
An Effort to Use a Laboratory Test as an Index of Combustion Performance.
On the Changing Size Spectrum of Particle Clouds Undergoing Evaporation, Combustion, or Acceleration.
Heat Transfer by Radiation From Flames.

COMPRESSORS
Operating Considerations In Application of Gas-Turbine-Driven, Centrifugal, Pipeline Compressors.
Problems Encountered in the Translation of Compressor Performance From One Gas to Another.
Skewed Boundary-Layer Flow Near the End Walls of a Compressor Cascade.
Inflow Conditions for Supersonic Compressor With Curved Blades.

COMPUTERS
A Mechanical Computing Device for the Analysis of One-Dimensional, Transient, Heat-Conduction Problems.
Application of Digital Computers to Bearing.
Two Applications of a Digital Design Computer to Machine-Design Problems.
Analog Computer for Nonlinear System With Hysteresis.
Method for Solving Problems of Irrotational Gas Flow.
The Application of an Analog Computer to the Measurement of Process Dynamics.

COOLING SYSTEMS
Mass-Transfer Cooling in a Laminar Boundary Layer With Constant Fluid Properties.
A Comparison of Refrigerants When Used in Vapor Compression Cycles Over an Extended Temperature Range.

COOLING TOWERS
Instrumenting a Field Study of Industrial Water-Cooling Tower Performance.
Cooling Towers for Steam-Electric Stations-Selection and Performance Experiences.

DIAPHRAGMS
Design of Corrugated Diaphragms.
Recent Research on Flat Diaphragms and Circular Plates With Particular Reference to Instrument Applications.
Investigation of Properties of Corrugated Diaphragms.

DIESEL ENGINES
Design and Development of a Two-Cycle Turbocharged Diesel Engine.
Future Developments of the High-Speed Diesel Engine.
Prevention of Destructive Engine Failure by Spectrographic Analysis of Crankcase Oils.
A Combustion System for Spark-Fired Gas Engines Using Diesel Compression Ratios.

ELASTICITY
The Spring Back of Metals.
Longitudinal Impact of Semi-Infinite Circular Elastic Bar.
Mixed Boundary-Value Problem of Elasticity.
Dislocation Over a Bounded Plane Area in an Infinite Field.
Elastic Coefficients of the Theory of Consolidation.
Calendaring of Viscoelastic Material.
Oblique Contact of Nonspherical Elastic Bodies.

ELECTRICAL ANALOGY
Responses of Temperature-Sensing-Element Analogs.
Solving the Melting Problem Using the Electric Analogy to Heat Conduction.
On the Dynamics of Pneumatic Transmission Lines.
Computer Representations of Engineering Systems Involving Fluid Transients.
Analysis of a Process-Fluid-Flow Network by Electrical Analogy.
Accuracy in Solution of Laplace's and Poisson's Equation.
Superharmonic Oscillations as Solutions to Duffing's Equation.

FLOW OF FLUIDS
Flow Through Annual Orifices.
Experimental Arrangement for Measurement of the Pressure Distribution on High-Speed Rotating Blade Rows.
Pressure Drop and Flow Characteristics of Short Capillary Tubes at Low Reynolds Numbers.
Orifice-Metering Coefficients and Pipe Friction Factors for the Turbulent Flow of Lead-Bismuth Eutectic.
The Unsteady Laminar Boundary Layer on a Flat Plate.
Experimental Study of the Velocity and Temperature Distribution in a High-Velocity Vortex-Type Flow.
Criteria for Validity of Lumped-Parameter Representation of Ducting Air-Flow Characteristics.
On the Adiabatic Couette Flow of a Compressible Fluid.
Heat Transfer to Laminar Boundary Layers With Variable Free-Steam Velocity.
Viscous Flow in a Narrowly Spaced Radial Diffuser.
Head Loss in Flow Through a Cyclone Dust Separator.
Two-Dimensional, Steady, Cavity Flow About Slender Bodies.
Point Source and Point Vortex in the Hodograph Plane.
Effect of Adverse Pressure Gradients on Turbulent Boundary Layers.
Unsteady Flow of Gas Through a Semi-Infinite Porous Medium.
Turbulence in Small Air Jets.

FLUID FRICTION
Heat-Transfer and Flow-Friction Characteristics of Woven-Screen and Crossed-Rod Matrixes.
Pressure Drop for Parallel Flow Through Rod Bundles.
Losses in Pipe and Fittings.

FRICTION
Electrical Effects Accompanying the Stick-Slip Phenomenon of Sliding of Metals on Plastics and Lubricated Surfaces.
Apparent Frictional Forces on Clamping Elements as Used in the Oil Industry.

FLUID METERS
Flow Sampling and Discharge Measurement in Geothermal Bores.
Fluid Flow Through Two Orifices in Series.

GAS TURBINES
Pressure Drop and Air-Flow Distribution in Gas-Turbine Combustors.
A Dynamic Performance Computer for Gas-Turbine Engines.
Research on Application of Cooling to Gas Turbines.
Operating Experience and Design Features of Closed-Cycle Gas-Turbine Power Plants.
Seal Leakage in the Rotary Regenerator and Its Effect on Rotary-Regenerator Design for Gas Turbines.

HEAT EXCHANGE EQUIPMENT
Mean-Temperature Difference in One, Two, and Three-Pass Crossflow Heat Exchangers.
Generalized Optimal Heat-Exchanger Design.

HEAT TRANSFER
Specific Heats of Liquid Metals and Liquid Salts.
Temperature and Velocity Distribution and Transfer of Heat in a Liquid Metal.
Convection Phenomena in Fluids Heated From Below.
Tests of Free Convection in a Partially Enclosed Space Between Two Heated Vertical Plates.
Turbulent Free-Convection, Heat-Transfer Rates in a Horizontal Pipe.
Determination of Thermal Conductivities of Metals by Measuring Transient Temperatures in Semi-Infinite Solids.
Natural-Convection Heat Transfer From a Horizontal Cylinder Rotating in Air.
Effect of Axial Fluid Conduction on Heat Transfer in the Entrance Regions of Parallel Plates and Tubes.
Heat Transfer in a Pipe Turbulent Flow and Arbitrary Wall-Temperature Distribution.
Heat-Transfer Rates to Crossflowing Mercury in a Staggered Tube Bank—1.
A Theoretical Analysis of Heat Transfer in Natural Convection and in Boiling.
Heat Transfer to Lead-Bismuth in Turbulent Flow in an Annulus.
New Finite-Difference Technique for Solution of the Heat-Conduction Equation, Especially Near Surfaces With Convective Heat Transfer.
Transient Air Temperatures in a Duct.
Experimental Studies of Free Convection Heat Transfer in a Vertical Tube With Uniform Wall Heat Flux.
Rate of Temperature Change of Simple Shapes.
Velocity, Temperature, and Heat-Transfer Measurements.
A New Method to Measure Prandtl Number.
The New Zealand Thermal Area and Its Development for Power Production.
Ebullition From Solid Surfaces in the Absence of a Pre-Existing Gaseous Phase.

HYDROSTATIC TESTING
Strength Characteristics of Rock Samples Under Hydrostatic Pressure.
General Instability of a Ring-Stiffened, Circular Cylindrical Shell.

IMPACT
High-Speed Impact Phenomena.
Sine Transforms in Timoshenko-Beam Impact Problems.
Motion and Stress of an Elastic Cable Due to Impact.
Stresses in Beams During Transverse Impact.

IMPELLERS
Effect of the Volute on Performance of a Centrifugal-Pump Impeller.
An Experimental Study of Centrifugal-Pump Impellers.

INSTRUMENTS
Measurement and Integration of Acceleration in Inertial Navigation.
Estimation of Temperature Patterns in Multiply-Shielded Systems.
Method for Presenting the Response of Temperature-Measuring Systems.
Instrumentation for Steam-Consumption Tests on Medium Steam Turbine-Generator Sets.

MACHINE DESIGN
On the Applicability of Notch Tensile Test Data to Strength Criteria in Engineering Design.
Graphical Shoe-Brake Analysis.

MANAGEMENT
Plant Management and Other Factors Affecting Maintenance Costs in Steam-Generating Stations.
Maintenance Factors Affecting Production Costs.
Practical Equipment-Replacement Economics.
Applying Linear Programming to Inventory Planning in a Seasonal Market—A Case Study.

2852 Pages **Over 1000 Illustrations** **$15.00—$7.50 to ASME members**
($1.50 additional for postage outside of the U.S.)

THE AMERICAN SOCIETY OF

Providing in these 324 papers and discussions authoritative information on engineering developments basically new and significant; on noteworthy theories, principles and practices; on the newest trends; and on important developments in designs, materials, processes, equipment, and power generation.

MATHEMATICS
A Practical Application of Uncertainty Calculations to Measured Data.
Min-Max Solutions for Linear Mass-Spring System.

MECHANISMS
An Application of Complex Geometry to Relative Velocities and Accelerations in Mechanisms.
Kinematic Analysis and Synthesis Using Collineation-Axis Equations.
Two Applications of a Digital Computer to Machine-Design Problems.
Synthesis of Four-Bar Mechanisms by Method of Components.
Axisymmetric Thermal Stresses in Spherical Shell.
Mobility of Levers Having Uniformly Distributed Mass.
Five-Line Construction for a Computing Linkage.

METAL CREEP
Creep Damage in a Cr-Mo-V Steel as Measured by Retained Stress Rupture Properties.
Certain Departures From Plastic Ideality at Small Strains.
Nonhomogeneous Yielding of Steel Cylinders, 1—Mild Steel.
Creep Characteristics of Type 347 Stainless Steel at 1050 and 1100 F in Tension and Compression.
Effect of Stress on Creep at High Temperatures.
Creep of Thick Tubes Under Internal Pressure.

METAL CUTTING AND GRINDING
Some Studies of Angle Relationships in Metal Cutting.
On the Drilling of Metals, 2—The Torque and Thrust in Drilling.
The Influence of Lead on Metal-Cutting Forces and Temperatures.
Force Relationships in the Machining of Low-Carbon Steels of Different Sulphur Contents.
Leaded Steel and the Real Area of Contact in Metal Cutting.
Cutting-Fluid Evaluation.
Comparative Machinability of B1113-C1213-C1120HR-C1120CD and C1119 Steels.
Some Experiments on the Influence of Various Factors on Drill Performance.
Influence of Grinding Fluids Upon Residual Stresses in Hardened Steel.

METAL FINISHING
Effect of Surface Finish on the Fatigue Strength of Titanium Alloys RC 130B and Ti 140A.
Ultrafinishing—A New High-Precision Lapping Process.

METAL TESTING
Effects of Complex Stress-Time Cycles on the Fatigue Properties of Metals.
Fatigue of Metals Under Combinations of Stresses.
Delayed-Yield Time Effects in Mild Steel Under Oscillatory Axial Loads.
The Flow and Fracture of Nodular Cast Iron.
Theoretical Criterion for Fracture of Metals.
Statistical Appraisal of the Prot Method for Determination of Fatigue Endurance Limit.

NONLINEAR SYSTEMS
Nonlinear Phenomena.
Optimum Nonlinear Control.
On the Analysis of Linear and Nonlinear Systems.
Determination of the Characteristics of Multi-Imput and Nonlinear Systems From Normal Operating Records.
Representation of Nonlinear Functions of Two Input Variables on Analog Equipment.
A Resume of Development and Literature of Nonlinear Control-System Theory.
Basic Methods for Nonlinear Control-System Analysis.
How to Obtain Describing Functions for Nonlinear Feedback Systems.
The Phase-Space Method for Analysis of Nonlinear Control Systems.

NOZZLES
Effect of Ambient and Fuel Pressure on Nozzle Spray Angle.
Design of Supersonic Expansion Nozzles and Calculation of Isentropic Exponent for Chemically Reacting Gases.
An Investigation of the End-Wall Boundary Layer of a Turbine-Nozzle Cascade.

PHOTOELASTICITY
A Photoelastic Study of Strain Waves Caused by Cavitation.
Experiments for the Determination of Transient Stress and Strain Distribution in Two-Dimensional Problems.

PIPE AND PIPING SYSTEMS
Materials Aspect of Some High-Temperature, Refinery-Piping Applications.
Effect of Internal Pressure on Flexibility and Stress-Intensification Factors of Curved Pipe or Welding Elbows.
Eight Years of Experience With Austenitic Steel Piping Materials at Elevated Steam Conditions.
Metallurgical Considerations of Main Steam Piping for High-Temperature, High-Pressure Service.
Austenitic Steels in High-Temperature Steam Piping.
An Investigation of Thermal-Stress Fatigue as Related to High-Temperature Piping Flexibility.

PLASTICITY
New Method for Construction of Hencky-Prandtl Nets.
Displacements in a Wide Curved Bar.
Plane Plastic Flow of an Inset Block.
Principle of Haar and von Karman in Plasticity Problems.

PLATES
Axisymmetrical Bending of Circular Plates.
Note on Way's Solution for Clamped Circular Plate.
Solution of Problems in Bending of Plates by Method of Muskhelishvili.
Uniformly Loaded Circular Plates With a Central Hole.
Analysis of Stresses and Strains Near End of a Crack.
Finite Twisting and Bending of Thin Plates.
Flexural Vibrations of Stiffened Plates.
Stresses in a Strip With Two Pairs of Semicircular Notches.
Force in the Plane of Two Joined Semi-Infinite Plates.

POWER PLANTS—*Nuclear, Steam, Solar*
Fuel Elements for Nuclear Reactors.
Reactor Shielding.
Methods of Refueling Heterogeneous Nuclear Reactors.
Operating Experience and Design Features of Closed-Cycle Gas-Turbine Power Plants.
Safeguard Features of a Fast-Breeder-Reactor Power Plant.
First Commercial Supercritical-Pressure Steam-Electric Generating Unit, Steam Generator, and Steam Turbine-Built for the Philo Plant.
Predicting Performance of Large Steam Turbine-Generator Units for Central Stations.
A New Way to Simplify the Steam Power Plant.
An Analytic Procedure for Optimizing the Selection of Power-Plant Components.
Avon No. 8—A Supercritical-Pressure Plant.
Engineering the Eddystone Plant for 5000-Lb 1200-Deg Steam and the Steam Generator for 5000-Psig, 1200-F Steam.
The Effect of Condensate Reheat on Mean Temperature Difference in Feedwater Heater Subcooling Zones.
Power From Solar Energy.

POWER SYSTEMS
A New Automatic Dispatching System at Kansas City.
Integration of Steam and Hydro Power in Northern California.

ROTORS
Nonuniform Rim-Stress Conditions for a Rotating Solid.
Stress Distributions in Rotating Disks Subjected to Creep.

SERVOMECHANISM
A Dual-Mode Damper-Stabilizer Servo.
Hunting Due to Lost Motion.
Analysis and Design of a Servomotor Operating on High-Pressure Compressed Gas.
Nonlinear Integral Compensation of a Velocity-Lag Servo-mechanism With Backlash.
Electrohydraulic Servomechanism With an Ultrahigh-Frequency Response.
Nonlinear Analog Study of a High-Pressure Pneumatic Servomechanism.
Design and Analog-Computer Analysis of an Optimum Third-Order Nonlinear Servomechanism.
Design Basis for Cascade-Type Positional Servomechanisms.

SHELLS
Ideal Reducers and Nozzle Flares.
Radial Deflections of a Cylinder Subjected to Radial Loads.
Deformation of Elastic Paraboloidal Shells of Revolution.
Cylindrical Shells Under Line Load.
Behavior of Cylinders With Initial Shell Deflection.

STEAM TURBINES AND TURBINE TESTING
Estimating Partial-Load Performance of Large Reheat Turbine-Generator Units.
The Eddystone Superpressure Unit.
Importance of Matching Steam Temperatures With Metal Temperatures During Starting of Large Steam Turbines.
Instrumentation for Steam-Consumption Tests on Medium Steam Turbine-Generator Sets.
Procedures for Testing Large Steam Turbine-Generators in Central Stations.

STEAM SUPERHEATERS
High-Temperature Corrosion of Alloys Exposed in the Superheater of an Oil-Fired Boiler.
Experimental Superheater for Steam at 2000 psi and 1250F.

STRESSES AND STRAINS
Influence of Repeated Bending Loads on Biaxial Residual Stresses in Shot-Peened Plates.
Yield Loads of Slabs With Reinforced Cutouts.
Stresses and Displacements in an Elastic-Plastic Wedge.
Stress Distribution at Base of Stationary Crack.
Effect of Circular Hole on Pure Twist of Infinite Strip.
A Theory of Adhesive Scarf Joints.
Some Mixed Boundary-Value Problems of the Semi-Infinite Strip.
Stress-Concentration Factors in Shafts.
Stresses in a Perforated Strip.
Saint Venant's Principle: A Biharmonic Eigenvalue Problem.
Direct Method for Determining Airy Stress Functions.
Analysis of Stress Distributions by Superposition.
Torsion of Circular Shafts of Variable Diameter.
The Sector Problem.
Stress-Strain Relations of a Granular Medium.

STRUCTURES
Design Charts for Symmetrical Ring Girders.
Response of Mechanical Systems to Random Excitation.
Effect of Boundary Conditions in Limit Analysis of Plastic Structures.
Negative Group Velocities in Continuous Structures.

THERMAL STRESSES
Thermal Stress and Deformation.
Photothermoelasticity: An Exploratory Study.

THERMODYNAMICS
Mollier Diagrams for Water Near Bubble Point.
The State Principle—Aspects of Relationship Among Properties of Systems.

VALVES
Use of Nonlinear Valve Characteristics in the Control of a Simple Blending Process.
Contributions to Hydraulic Control—7, Analysis of the Effects of Nonlinearity in a Valve-Controlled Hydraulic Drive.
Cavitation Characteristics of Gate Valves and Globe Valves Used as Flow Regulators Under Heads Up to About 125 Feet.
Pressure-Flow Characteristics of Pneumatic Valves.
Resistance Coefficients for Laminar and Turbulent Flow Through One-Half-Inch Valves and Fittings.
Compensation of Steady-State Flow Forces in Spool-Type Hydraulic Valves.

VIBRATION
Noise, Vibration, and Measurement Problems, Resulting From Fluid-Flow Disturbances.
Vibration Design Charts.
Vibration Modes of Stators of Induction Motors.
Dependence of Frequency Spectrum of Circular Disk on Poisson's Ratio.
Forced Vibration of a Body on an Elastic Stratum.
Improvement of Holzer Table Based on Suggestion of Rayleigh's.
Graphical Solution of a Nonlinear Vibration Problem.
A Type of Flame-Excited Oscillation in a Tube.
Forced Vibration of Systems With Nonlinear Characteristics.
The Forced Lateral Oscillations of Trailers.
An Elongating String Under Action of Transverse Force.
Effect of Elastic Racks on Vibration Mounting of Equipment.

WAVE MECHANICS
Reflection of Dilatational Waves at Edge of a Plate.
Propagation of Compressional Waves in a Dispersive Elastic Rod—Part I.
Propagation of Compressional Waves in a Dispersive Elastic Rod—Part II.
Response of Nonlinearly Supported Boundaries to Shock Waves.
Velocities of Long Waves in Plates.

MISCELLANY
Investigation of Causes of Low Wheel-to-Rail Adhesion and Possible Methods of Improving It.
Experimental Investigation of Critical Design Factors for Vane-Type Cyclones.
Drag-Turbine Performance.
Fork-Truck Stability—A Study in Moments.
Effect of Cold Work on Elevated-Temperature Properties of Types 301, 305, and 310 Stainless Steels.
Jet-Pump Theory and Performance With Fluids of High Viscosity.
Compressibility of a Sphere Pack.
Corrections for the Oscillating-Disk Viscometer.
How RF Concerns the Wood Industry.

MECHANICAL ENGINEERS
29 W. 39th St., New York 18, N. Y.

Do not be without the

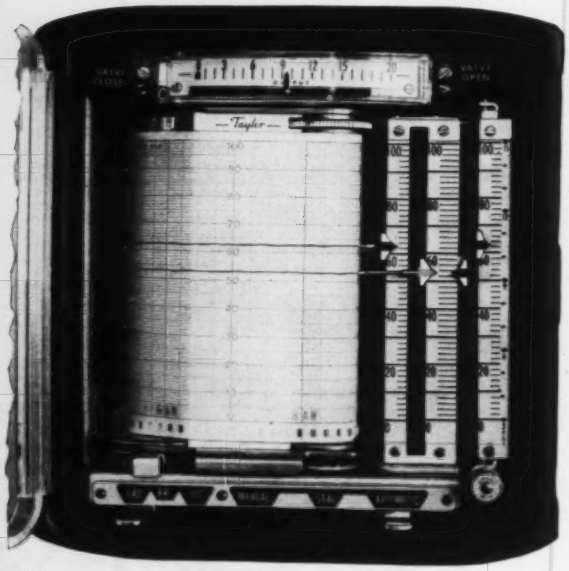
77-YEAR INDEX TO ASME TECHNICAL PAPERS

It offers the quickest and easiest way to tap the rich fund of information on more than 10,000 subjects published in the ASME Transactions, the Journal of Applied Mechanics, and Mechanical Engineering from 1880 to 1956.

If you do not have these magazines, they can be consulted in one of the many public libraries and engineering college libraries that maintain complete files of them. If not within easy reach of these sources, photostats or microfilms of any article or articles wanted can be purchased from the Engineering Societies Library.

382 Pages Cloth Binding $20—$16 to ASME members.

Complete Cascade System in ½ Normal Space ...Costs Substantially Reduced



Taylor's New TRANSCOPE Plug-in Recorder provides a complete Cascade System . . . in half the space required by other systems*

Never before has a complete cascade system been available in one recorder case in a 6" panel cut-out.

Complete Cascade System. All switches in one case. Operator performs all start-up and shut-down operations in one recorder. No external switches or relays. No extra space needed. Cascade set point always in view.

All Functions in One Case. Master and secondary variables continuously recorded. Master and secondary controller outputs, as well as set points, continuously indicated.

Unique, New Bumpless Transfer. New switching system lets you change from *control by secondary* to *control by master,* precisely matching the master output to the secondary control point without comparing gages.

Front of Panel Control Settings let you make adjustments easier, quicker and better! You can clearly see what you are doing, and the results, because the record is continuous.

Stays on Automatic Control while the recorder is removed. There's no need to shut down the process for instrument service or adjustments.

Substantial Cost Reduction. You save substantially since you need only one case, one chart drive, one panel cut-out, one set point transmitter.

★ ★ ★

For further information about this revolutionary new Recorder, see your Taylor Field Engineer, or write for **Bulletin 98286.** Taylor Instrument Companies, Rochester, N.Y., Toronto, Ontario.

*Trade-Mark

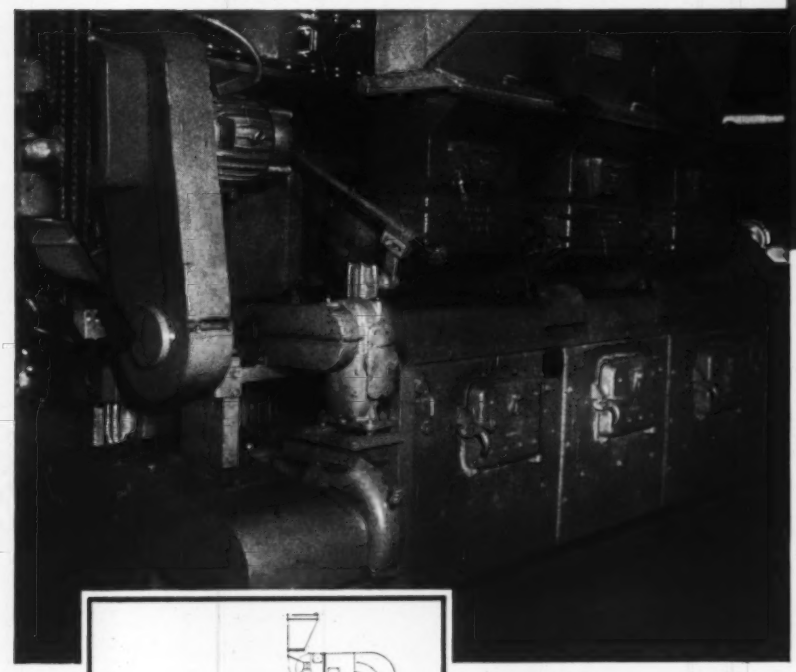
CASE MATES!

The Taylor TRANSCOPE Controller and Recorder are companion plug-in instruments. Together they give new standards of process control performance... unprecedented stability, accuracy and adaptability. Especially suited for the short spans of measurement encountered in present day processing. The TRANSCOPE Controller is insensitive to ambient temperatures, and highly resistant to mechanical shock. Write for **Bulletin 98278.**

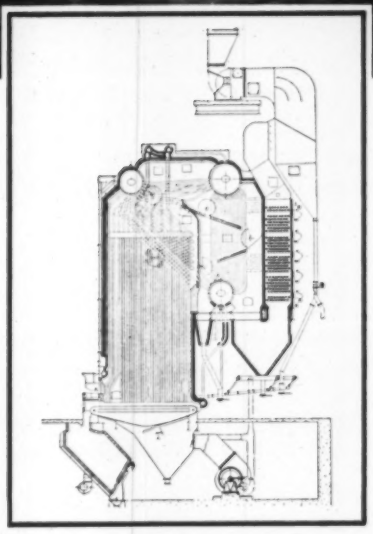
Taylor Instruments MEAN ACCURACY FIRST

Availability?...

HERE'S A RECORD TO SHOOT AT.....Only 5 HOURS OUTAGE in 5 years



A Detroit RotoGrate Stoker



AT OTSEGO

Detroit RotoGrate Stoker with Wickes Boiler; 650 pounds pressure, 750°F temperature. Cummins & Barnard, Consulting Engineers.

This record of only 5 hours outage in over 5 years is reported by Otsego Falls Paper Mills, Otsego, Michigan, a division of Menasha Wooden Ware Corporation.

Walter Boettcher, Chief Power Engineer says: "*5 hours in 5 years and 4 months is the record of down time due to the RotoGrate Stoker outage*" in this well operated single boiler plant.

"*It operates 24 hours a day—5 to 6 days a week, 60,000 to 90,000 pounds of steam per hour.*

"*Paper mill load fluctuations handled easily without pressure loss.*"

This record indicates a fine job of equipment maintenance, but high availability can be taken for granted with the DETROIT ROTOGRATE.

A customer survey taken in all kinds of plants proves it.

DETROIT ROTOGRATE COSTS LESS

Cost = initial investment + upkeep + production losses due to outage of equipment. The total is less with RotoGrate.

DETROIT STOKERS

DETROIT STOKER COMPANY

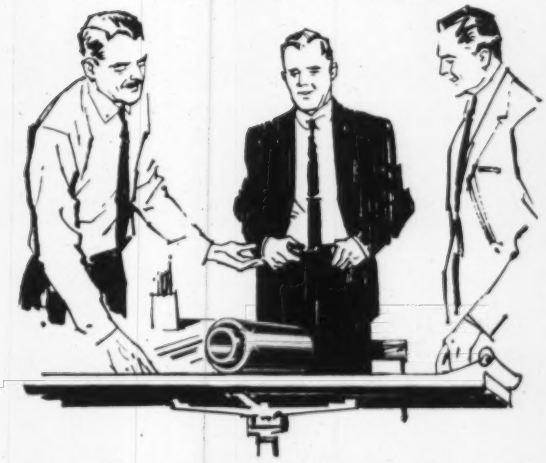
MAIN OFFICE AND WORKS • MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

NOW he is like a tightly wrapped bud. But, petal by petal, you will help the future unfold in your child. Sobering idea, isn't it? Makes a thoughtful parent resolve to begin saving now for the richer future a good education can provide. And what better way to save than with U.S. Savings Bonds? Where nothing can harm that education fund. Where saved dollars earn 3¼% interest when Bonds are held to maturity. And where saving is surer—because you can buy Bonds regularly where you bank or automatically through the Payroll Savings Plan where you work. Why don't you start your Bond program today? Make life more secure for someone you love.

The U. S. Government does not pay for this advertisement. It is donated by this publication in cooperation with the Advertising Council and the Magazine Publishers Association.

You can have new freedom of design and improved products



with Custom-fabricated
FLEXIBLE BEARINGS
by Bushings, Inc.

Flexible Bearings by Bushings, Inc. absorb shock, vibration and noise. They correct for misalignment, reduce shaft-wear and help insure a quiet, smooth running, longer lasting product with higher consumer satisfaction.

Flexible Bearings by Bushings, Inc. are custom-fabricated to your specifications and when designed into your product give you these advantages:

- **Freedom from limited "stock" sizes—Flexible Bearings by Bushings, Inc. are designed to fit your specific use.**
- **You get an improved product that will give outstanding service and long life.**
- **You can have fast, authoritative engineering advice, help and service *at the design stage* merely for the asking.**

Flexible Bearings by Bushings, Inc. is at your service, NOW. Simply write to Harvey G. Moore at the address below.

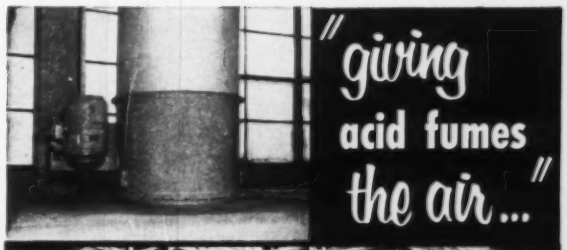
For more than 15 years Bushings, Inc. has custom-fabricated bearings in a wide range of metals and sizes for hundreds of different manufacturers.

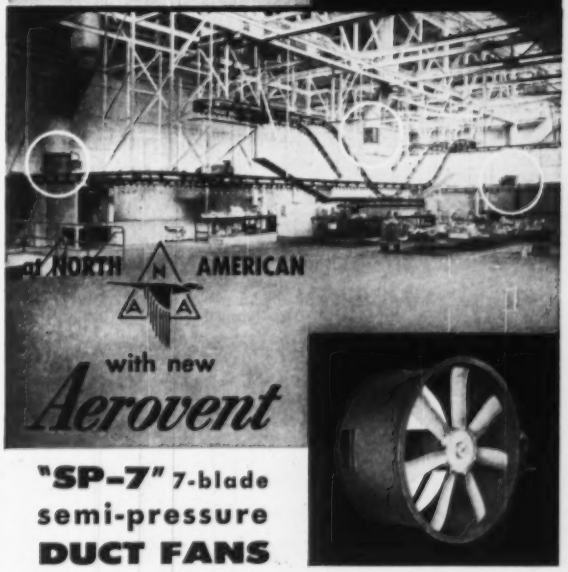
VIBRO-LEVELER MOUNTS dampen vibration, permit precision leveling of machines.

SILENT-LIGN PILLOW BLOCKS for shaft mounting. Has all Flexible Bearing features.

Bushings, Inc.

4358 COOLIDGE HIGHWAY • ROYAL OAK, MICHIGAN





"SP-7" 7-blade semi-pressure DUCT FANS

Installed at the Columbus, Ohio plant of North American Aviation, Inc., new Aerovent "SP-7" Belt-Driven Duct Fans, with 7-blade "Macheta" Airfoil Propellers, remove acrid fumes and vapors from a spray-type processing machine. At temperatures of 180° to 200° F., the solution flashes into steam and noxious fumes which would contaminate the entire area if unabated. Located above each end of the spray section, and at intermediate points, the fans induce a steady flow of air through the unit to trap and remove heavy vapors at their source.

Recommended for resistances in the ¾" to 2½" S.P. range, these units, designed for all standard duct systems, move *more air* with less horsepower; provide greater mechanical efficiency with lower initial and operating costs. May be ordered with special-duty motors, alloy propellers and special protective coatings for extreme temperature, moisture or corrosive conditions.

WRITE FOR FREE BULLETIN NO. 400

"SP-7" FANS FOR ALL INDUSTRIAL REQUIREMENTS

DIRECT CONNECTED
Steel ring or square panel for wall, ceiling or penthouse. 14" to 60". Used with extended shaft for heat, moisture or corrosion.

DIRECT-DRIVEN DUCT
For installations which permit connection of entire fan assembly in air-stream. For vertical or horizontal use. 14" to 60".

"BI-FLO" DUCT
New divided-duct design, for air-supply or exhaust. Motor located out of airstream. Also serves as stock booster. Sizes 18" to 48".

***"EFFICIENCY-ENGINEERED"* equipment for every air-handling problem!**

Rated in accordance with Standard Test Code and U.S.D.C. Comm. Std. CS178-51.

Aerovent FAN CO. INC.
Ash and Beach Sts. Piqua, Ohio

DeZurik's *exclusive* eccentric principle guarantees easy operation and tight closure every time . . . on any line! Their resilient faced plugs seal around solids in the flow.

ECCENTRIC ACTION

The plug in a DeZurik Valve is pivoted eccentrically, matching the eccentrically-raised seat. The plug contacts the body *only* when the valve is shut. In opening the valve, the contact is broken and the plug swings aside without friction, without binding!

NO LUBRICATION is required on a DeZurik Valve to achieve easy operation or tight shut-off. Eccentric action and resilient plug facing assure positive closure and friction-free operation!

FOR SO MANY plant applications, DeZurik Valves offer so much more; top efficiency, minimum maintenance, longer life. Why not see for yourself? Representatives in all principal cities, or write to

DeZURIK
CORPORATION
SARTELL, MINNESOTA

The NICE Way to Lower Cost...

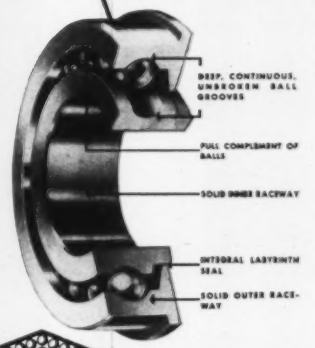
Premium Performance at Lower Cost

with BALL BEARINGS of Revolutionary New Construction!

NICE now offers the revolutionary new UNIBAL*... a low cost ball bearing of superior quality and greater durability, suitable for requirements ranging from the commercial field to many precision applications heretofore using conventional ground bearings. Its simplified construction and assembly method incorporates a new concept in design.* There are no loading slots... no split raceways, yet there is a full complement of balls.

Deep, unbroken ball grooves, with closer tolerances and improved finish, provide quiet, smoother operation, with maximum capacity for radial and thrust loads.

UNIBAL Ball Bearings can be furnished in single row, double row, flanged or snap ring types in a wide range of widths and diameters, and the novel construction permits a variety of shield and seal devices.



Your Inquiries Invited.

*Patent Applied For.

NICE®

NICE BALL BEARING CO.
NICETOWN • PHILADELPHIA • PENNSYLVANIA

MECHANICAL ENGINEERING
May, 1958 CARD INDEX Vol. 80, No. 5

Sharpen the Truth, R. M. Nixon	56
Flow of Coal, F. D. Cooper and J. R. Garvey	58
Testing the Oil Industry's Meters, M. L. Barrett, Jr.	61
Management and Engineering in the Age of Automation, A. Harvey	66
Designing for Safety, N. Prasinos	70
Cooling Towers, E. E. Goitein	74
Adventure in Science, J. H. Keenan	79
A Research Sawmill, W. K. Stamets, Jr., and K. C. Compton	84
1958 Nuclear Congress—Availability List	113
Editorial	55
Briefing the Record	86
Photo Briefs	94
European Survey	96
ASME Technical Digest	98
Comments on Papers	116
Reviews of Books	121
Books Received in Library	122
The Roundup	124
The ASME News	130

For Reference

A 20-PAGE LIST OF ASME PUBLICATIONS

is included in the

1958 MECHANICAL CATALOG

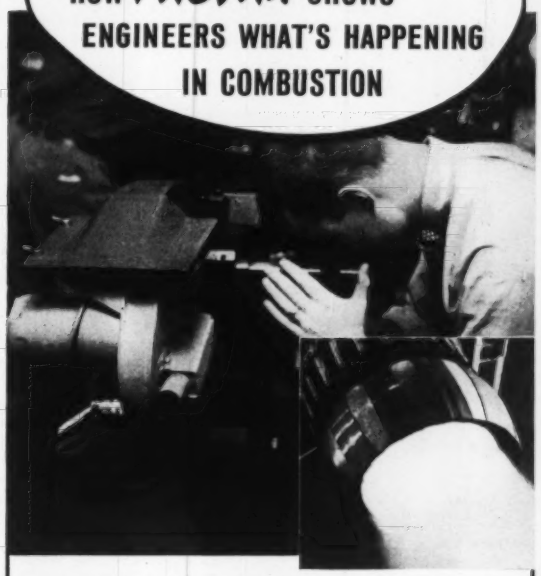
Copies of the List are obtainable from

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Publication-Sales Dept.

29 West 39th St., New York 18, N. Y.

HOW *FASTAX* SHOWS ENGINEERS WHAT'S HAPPENING IN COMBUSTION



PRATT & WHITNEY AIRCRAFT ENGINEER GETS CLOSE-UP VIEW OF COMBUSTION PROCESS WITHIN THE AFTERBURNER OF ADVANCED JET ENGINE TEST. FASTAX HIGH SPEED MOTION PICTURE CAMERA SIMULTANEOUSLY RECORDS PROCESS.

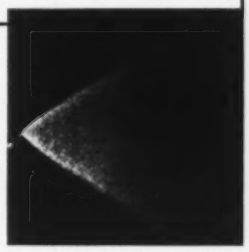


Photo of atomization and distribution of fuel in fuel injection system under flight condition.

The combustion principles in the modern aircraft engine are extremely important to test engineers at Pratt & Whitney Aircraft, for the design and development of high heat release rate devices. The ignition of the mixture of air and fuel in the proper proportions, and the rapid mixing of burned and unburned gases involve a most complex series of interrelated events—events occurring simultaneously in time and space. Only by slowing up this fast-moving action with a FASTAX High Speed camera at speeds up to 5,000 frames per second, and projecting this film at a normal 16 frames a second can the engineers see what is happening for later study and evaluation. The highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the Pratt & Whitney Aircraft engineers.

WF-17 FASTAX
Combined motion picture and oscillographic camera

WRITE for Bulletin FA-16 for more detail information.

WOLLENSAK
OPTICAL COMPANY • ROCHESTER 21, N.Y.

"MONOBALL"®
Self-Aligning Bearings

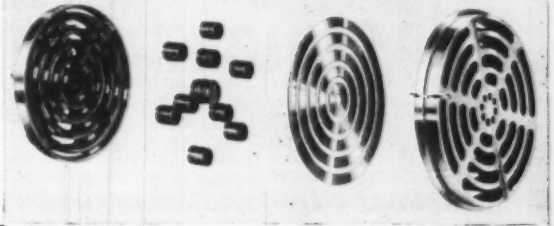
CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Dept. ME-58.

SOUTHWEST PRODUCTS CO.
1705 SO MOUNTAIN AVE MONROVIA, CALIFORNIA

install VOSS VALVES in your compressors for peak performance
(AIR • GAS • AMMONIA)



Peak performance, maximum efficiency, greater output, and lower power costs can be built into your oldest, and of course your newest, compressors by the installation of VOSS VALVES.

Check THESE VOSS VALVE ADVANTAGES:

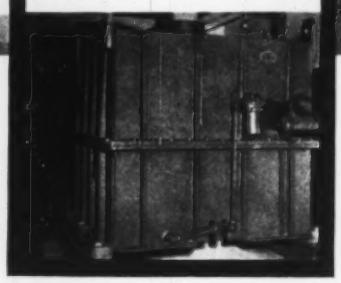
- Quiet, vibration-free operation
- 20 to 60% more valve area
- less power consumption
- minimum pressure loss
- normal discharge temperature
- lower operating costs
- utmost safety

Our detailed proposal for increasing efficiency of your compressor will be sent without obligation. Send name, bore, stroke, and speed of your machine.

VOSS VALVES
J. H. VOSS CO., INC.
785 East 144th St., N.Y. 54, N.Y.

(Above) Cutting 64 inch spiral bevel gear on new precision gear generator.

(Below) Interior of rotor test stand showing Philadelphia Spiral Bevel Reducer. 1300 hp motor is in background.



Special 1300 hp Philadelphia Reducer drives helicopter rotor test rig...

Testing 90-foot helicopter rotors involved problems of torque and vibration, plus precise speed control and test rig maintenance. Kaman Aircraft Corp., Bloomfield, Conn., found the answer in a special spiral bevel Philadelphia Reducer driven by a 1300 hp variable speed DC motor.

This Philadelphia designed drive completely eliminated vibration and torque variation previously encountered in engine driven rigs. Maintenance is simpler. Precise speed control can be obtained at rotor speeds from 200 to 400 rpm.

For any right angle drive application, standard or special, Philadelphia Spiral Bevel-Helical Reducers will take more abuse and last longer under the most severe load conditions. One of the reasons is that all Philadelphia spiral bevel gears and pinions are heat treated and hardened *after* they are cut . . . then lapped to a mirror-like finish. Helical Gearing is precision hobbed on the newest, most modern equipment. The gear teeth are then crown shaved and induction hardened.

Result: better tooth contact, longer gear life. Units are vibration-free and quieter. On special applications, where conditions warrant, both spiral bevel and helical gearing can be furnished with precision ground teeth.

You can select a Philadelphia Spiral Bevel Reducer—or have one specially built—to suit your precise needs. Our Spiral-Bevel units provide ratios as low as 1 to 1, or as high as 238 to 1. Units are available in single, double or triple gear reductions—in both vertical and horizontal types. Catalog SB-57 describes them all. Write for your free copy today.

PHILADELPHIA GEAR CORPORATION
Erie Avenue and G Street • Philadelphia 34, Pennsylvania

philadelphia gear drives

Offices in all Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.
INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

OPPORTUNITIES

positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.00 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $40.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

POSITIONS OPEN

LAY-OUT & DESIGN DRAFTSMAN

Leading national manufacturer of automatic control equipment requires Draftsman experienced in valve design and lay-out. Comparable background will be considered. Thorough practical experience of 5-10 years' preferred rather than technical degree.

Excellent opportunity for right man with a progressive, forward looking company offering broad employe benefit program. Apply in writing submitting resume, indicating expected starting salary.

LESLIE CO.
Valley Brook Ave., Lyndhurst, N. J.

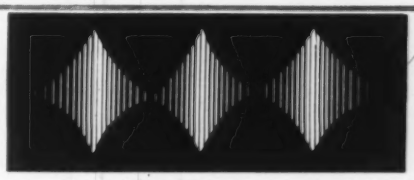
APPLIED MECHANICS

This industrial research organization has openings on its staff at Cambridge for experienced mechanical engineers interested in applying their knowledge of analytical methods to the solution of a variety of technical problems in industry and Government. Work includes stress analysis, vibrations, dynamics, fluid mechanics and acoustics.

Applicants must have M.S. or Ph.D. (or equivalent) in analytical engineering, plus at least five years in stress analysis in industry. Should be able to do independent advanced work and have established reputation in applied mechanics.

Send resume to CHARLES N. SCHOCK.

Arthur D. Little, Inc.
ENGINEERING DIVISION
CAMBRIDGE 40, MASSACHUSETTS



ENGINEER, ME

FLUTTER & VIBRATION ANALYST

Senior Position With General Electric

Several years experience in vibration analysis of turbo machinery assemblies – plus a strong background in fundamental concepts and applications in this field–are essential for this advanced assignment. M.S. desirable.

The work concerns the development of *nuclear power systems for aircraft* at General Electric. It deals specifically with high-temperature reactor core components.

Engineers who have contributed to the pioneering effort to achieve nuclear powered flight will find themselves in the forefront of their profession.

Is Nuclear Experience Necessary? No. In-plant courses and graduate study – on full tuition refund basis–provide essential nuclear theory and technology.

Publication of technical papers is encouraged

Location: Cincinnati, Ohio, known both as an engineering center and a fine place to live. Excellent housing available.

Please write in confidence, stating salary requirements to:
Mr. P. W. Christos

AIRCRAFT NUCLEAR PROPULSION DEPT.

GENERAL ELECTRIC

Div. 40-MR, P. O. Box 132 Cincinnati 15, Ohio

CHIEF ENGINEER

This well-established firm with nation-wide markets requires a technically proven engineer to assume full responsibility for its engineering program. This plant is engaged primarily in heavy manufacturing and fabrication of steel-alloy products in such fields as nuclear, missile, pressure vessel and special heavy machinery, which involve advanced welding techniques and precision machine shop operations.

The person selected should have experience in administering an engineering department, which includes both design and production engineering and should have knowledge of related manufacturing processes, materials, and costs.

Location West Coast. Salary open. Please send complete resume. Your reply will be treated confidentially and will be acknowledged promptly.

Address CA-6486, care of "Mechanical Engineering."

It will pay you to read the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

"OPPORTUNITIES" 233-238

ENGINEERS • SCIENTISTS

R & D Opportunities in CALIFORNIA With SYLVANIA

At Sylvania's Mountain View Laboratories, there are unlimited opportunities for the engineer who wants to work in an environment where individual contributors are recognized as the basic ingredient in creative engineering, and advancement is based on ability. There are openings now for:

MECHANICAL DEVELOPMENT ENGINEERS
To work with project teams doing mechanical development in varied areas including servo and power gearing, heat transfer, fabrication, human engineering, electronic packaging, antenna design.

MECHANICAL TUBE ENGINEER
To perform mechanical design on tubes, components and tooling including heat transfer, environmental requirements, test procedures, write up and test evaluation.

DEVELOPMENT ENGINEERS
Advanced R&D in the fields of electronic countermeasures and electronic systems; responsible for circuit and equipment design and development in the areas of transmitters, receivers, analyzers, direction finders, data handling, RF circuits and antennas.

SYSTEMS ENGINEERS
Perform advanced systems analysis and design applying background in EE, math or physics to problems in the areas of radio and microwave techniques.

MICROWAVE TUBE SPECIALIST
To perform advanced R&D on special purpose tubes such as Klystrons, Traveling Wave Tubes and Backward Wave oscillators.

There are also openings for:

PRODUCT ENGINEERS
FIELD ENGINEERS
MATHEMATICIANS
STATISTICIANS
PHYSICISTS

Mountain View Laboratories
ELECTRONIC DEFENSE LAB
RECONNAISSANCE SYSTEMS LAB
MICROWAVE PHYSICS LAB
MICROWAVE TUBE LAB

Please send your resume to
Mr. J. C. Richards

SYLVANIA
SYLVANIA ELECTRIC PRODUCTS INC.
P.O. Box 1296
Mountain View, California

MECHANICAL ENGINEER

Graduate mechanical engineer in power plant design work. Experience not required. Excellent opportunity with consulting engineering firm in the Middle West. Liberal benefit plans and good working conditions.

Send resume of education and experience with statement of salary requirements.

Address CA-5905, % "Mechanical Engineering."

SALES ENGINEERS WANTED

for Chicago and Houston. Prefer men with Electrical, Mechanical or Chemical Engineering degrees. Successful applicants will receive three months' intensive training at factory in Waterbury, Connecticut before assignment to district office. Prefer men between 25 and 30 who can start as trainees. Previous sales and instrument experience desirable but not mandatory. Those interested in Chicago opening address reply to S. E. Gewin, District Manager, The Bristol Company, 351 E. Ohio Street, Chicago 11, Illinois. Those interested in Houston opening address reply to E. A. Merwin, District Manager, The Bristol Company, 3617 W. Alabama, Houston 6, Texas.

MANAGER RESEARCH & DEVELOPMENT

Direct all new product development and modification activities for a multi-division company in the mineral processing equipment field. West Coast location. Marketing research, planning and development of new products and services to improve the line. Direct project engineers and contracted services.

Compensation includes salary and bonus, plus liberal employee benefits such as hospitalization, life insurance and pension. In first reply, please include information regarding age, experience, compensation and education. All replies confidential.

Address CA-6488, % "Mechanical Engineering."

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—

Use a Classified Advertisement in
MECHANICAL ENGINEERING

MECHANICAL ENGINEER

An excellent opportunity for a high calibre man with a prominent long established Midwestern manufacturing plant. Applicant must have broad experience in the design, development of improvements and maintenance of industrial machinery. Papermaking and graphic arts operations experience desirable.

Duties will include the study, economic evaluation and recommendations for the coordination of operations.

Send complete resume, including education, experience and salary expected.

All replies will be held confidential. Send replies to:

Address CA-6479, % "Mechanical Engineering."

VALVE AND NUCLEAR ENGINEERS SALES ENGINEERS

Aggressive Research, Development and Selling have made Edward Valves, Inc., a leader in the steel valve industry. We are expanding our staff and facilities to maintain this position. Have opportunities for—
Engineers (mechanical stress, flow, materials, metallurgical) interested in design and development of valves for high pressure, high temperature service and nuclear power applications.
Sales Engineers—Recent Engineering graduates, preferably M.E. for approximately one year inside sales training prior to assignment to a territory.
Send complete resume in confidence.

EDWARD VALVES, INC.
Subsidiary of Rockwell Manufacturing Co.
1200 West 145th Street, East Chicago, Indiana
Mr. E. A. Loeser, Engineering Personnel

CAREER OPPORTUNITIES
with prominent paper manufacturer

MECHANICAL ENGINEERS
ELECTRICAL ENGINEERS
MECHANISM ENGINEERS
CONTROL ENGINEERS

West Virginia Pulp and Paper Company, one of the nation's leading multi-plant manufacturers of paper and paper products, is organizing an Equipment Engineering section to develop new production equipment. This unusual opportunity will call for bringing the results of research projects to commercial actuality; the advancement of present technology; and, the improvement of existing equipment.

The men we are seeking will have a strong interest in high speed paper machinery and related operations . . . men who are willing to accept the challenge of developing the *new and unconventional.*

Recent graduates with strong fundamental backgrounds, as well as several men with proven experience in this field, are desired.

All inquiries will be considered promptly and held confidential. Please contact:

Director of Research and Development
West Virginia Pulp and Paper Company
Covington, Virginia

A report to Engineers and Scientists from Lockheed Missile Systems— where expanding missile programs insure more promising careers

A beryllium test program designed by Division engineers helped Lockheed fly the first missile with a structural component fabricated from the high temperature metal.

Called the "hottest" material prospect of the Space Flight Age, beryllium is tested for creep rupture in an argon chamber to protect personnel from the material's toxic dust and oxide. The metal was heated to 1400°F by electrical resistance while under a constant load of 90% yield stress.

Other areas of activity in structures analysis and test include thermal buckling and stress, structural optimization in the time-temperature environment, and structural loads and dynamics.

BERYLLIUM CREEP TESTS LEAD TO PIONEER FLIGHT WITH LOCKHEED MISSILE

Progress on advanced activities like the beryllium tests is made possible through combined efforts of the Division's creative talent. Moreover, the ideal scientific environment is provided by our multi-million dollar research and development laboratories near Stanford University. And these activities and facilities will continue to grow as more emphasis is put on missile's role in U.S. defense.

This means your opportunities for rapid advancement are better now with Lockheed Missile Systems. Inquire today about openings for qualified scientists and engineers in: **Structures, Aerodynamics, Thermodynamics, Propulsion, Guidance, Gas Dynamics, Flight Controls, Instrumentation, Systems Integration, Human Engineering.**

Write Research and Development staff, Sunnyvale 6, California.

Lockheed

MISSILE SYSTEMS

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

SUNNYVALE • PALO ALTO • VAN NUYS
SANTA CRUZ • CALIFORNIA

Lou Riedinger, Strength Section Head, left, is pictured with Reg Foster, Head of the Weights Section, inspecting results of a recent test.

IBM

THERMODYNAMICS ENGINEER

Excellent opportunity for thermodynamics engineer with extensive experience in aircraft installation and cooling work. Should have good background in heat transfer, packaging and aircraft structures.

Qualifications

Engineering degree and 3 to 5 years' experience.

Advantages of IBM

A recognized leader in the electronic computer field; stable balance of military and commercial work; advancement on merit; company-paid relocation expenses; liberal company benefits; salary commensurate with ability and experience.

Immediate openings at Owego, N. Y.

Write, outlining qualifications and experience, to:

Mr. Paul E. Strohm, Dept. 598R
Military Products Div.
IBM Corporation
Owego, New York

IBM INTERNATIONAL BUSINESS MACHINES CORPORATION

DATA PROCESSING • ELECTRIC TYPEWRITERS • MILITARY PRODUCTS
SPECIAL ENG'G. PRODUCTS • SUPPLIES • TIME EQUIPMENT

Director of Sales

MECHANICAL EQUIPMENT

Well established company located in Middle Atlantic States has exceptional opportunity for Sales Director of their nationally known line of equipment products used throughout industry.

The man who will fill this position should have a minimum of 5–10 years in responsible sales management positions involving line and staff activities of industrial sales. Also, should have had experience in the analysis and exploitation of potential markets. Must be willing to travel extensively.

Age: 40–50. College graduate with degree in Mechanical Engineering preferred. Good salary plus other benefits.

Send complete resume of both personal and business qualifications in confidence to

Box CA-6490
c/o "Mechanical Engineering."

MECHANICAL ENGINEERS

Experienced in heating, plumbing, ventilation and air conditioning. College degree and four or more years' experience required.

For assignment on design projects in our air-conditioning Boston offices.

Write or call
Horace M. Smith
HAncock 6-3485

METCALF & EDDY

156 Stuart Street
Boston 16, Massachusetts

We are prepared to

LICENSE

our *Hydraulic Cranes* in the United States.

Our designs are especially suited to ships. They have been demonstrated to be

the best in the world.

HYDROKRANBAU-GESELLSCHAFT
Wiese & Co.
Glinde b.Hamburg/Glinder Weg
GERMANY

Opportunities Unlimited

ENGINEERING SOCIETIES PERSONNEL SERVICE INC. (AGENCY)

SECURITY...TOP WAGES...
CHALLENGING ASSIGNMENTS

Qualified Engineers! Thousands of positions available with leading organizations... Employer pays fee in many cases.

Under the auspices of the Four Founder Engineering Societies and affiliated with other renown Engineering Societies, E.S.P.S. offers many years of placement experience in addition to world wide contacts.

Write for E.S.P.S. weekly Bulletin of Positions Available... See a partial listing of available positions in Personnel Section.

DON'T DELAY—REGISTER TODAY

Offices In Major Cities In U. S.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

ON SEMICONDUCTOR FRONTIERS

YOU can help 'beat the heat' at 200°C

ELECTRONIC ENGINEERS

PHYSICAL CHEMISTS

SOLID STATE PHYSICISTS

ELECTRONIC ENGINEERS at TI are beating the semiconductor heat barrier with devices that will operate at 200 degrees centigrade and higher – twice the boiling point of water! Working closely with other scientists on the TI team, they continually explore new fields in electronics. Under the hot glare of infrared light which simulates extreme operating conditions, the engineer shown above is testing the newest TI silicon power transistor operating in conjunction with the totally new *Sensistor* temperature-sensing silicon resistor.

On this frontier, there is plenty of room for electronic engineers, physical chemists, solid state physicists, and others to build America's electronic future. If *you* are interested in joining other leading engineers and scientists at the industry's most modern research, development and production facilities – write or call for more information on 28-year-old Texas Instruments, recognized leader of the semiconductor industry. You will discover up-to-date supplemental benefits – profit sharing, insurance, retirement programs, and company-sponsored educational assistance.

Semiconductors and Other Components – Transistors, diodes, rectifiers, capacitors, resistors, transistor circuit applications, test equipment, mechanization. Write Harry Laur.

Electronic and Electromechanical Apparatus – Radar, sonar, infrared, optics, navigation, magnetics, telemetering, communications, computers, transformers. Write R. E. Houston.

Research and Manufacturing – PhD level for research, development and applications: solid state device technology, ferromagnetics, infrared, microwave, magnetics, digital computers, radar, sonar, telemetering, etc. Engineers for production, planning, purchasing, cost analysis, etc. Write A. E. Prescott.

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE • DALLAS 9, TEXAS

GA GENERAL ATOMIC

GENERAL ATOMIC
DIVISION OF GENERAL DYNAMICS CORPORATION
SAN DIEGO, CALIFORNIA

Accepting Applications from

MECHANICAL DESIGN ENGINEERS

with strong background in classical stress analysis and experience in stress model design and interpretation.

PLEASE SEND RESUME TO: H. H. MC GEATH, PERSONNEL REPRESENTATIVE, GENERAL ATOMIC, P.O. BOX 608, SAN DIEGO 12, CALIFORNIA

APPLICATION ENGINEER

This work is a part of a product-service group within an engineering department. You should have a keen interest in applying apparatus to the needs of the oilfield lease operator. You will be a link between the salesmen and the engineering group. Technical writing is a part of the work. For this job, we believe you should have 2 years or more experience with oil-country equipment as a gas engineer or production engineer. Some of this might well have been in sales work.

If this opening interests you, please send us a resume of your experience. We will reply promptly and your application will be held in confidence. Salaries for these positions are open and will depend upon your experience and ability. Address your reply to The Parkersburg Rig & Reel Company, Box 12007, Fort Worth, Texas.

POSITIONS OPEN

MECHANICAL ENGINEERING FACULTY—Assistant Professor or Instructor needed for Machine Design or Heat Power Field. Masters Degree required for Assistant Professorship. Salaries on nine-month basis open. Address: Head, Department Mechanical Engineering, University of North Dakota, Grand Forks, North Dakota.

ASSOCIATE and ASSISTANT PROFESSORS for fields of advanced dynamics, advanced strength, and elasticity. Also have opening for graduate student as half-time instructor. Engineering Mechanics Dept., Kansas University, Lawrence, Kansas.

SALES ENGINEER—College graduate, 25 to 30 years' old, experience power plant equipment, New Jersey resident, work New York and New Jersey. $7500. Address CA-6325, care of "Mechanical Engineering."

ENGINEER, M.S. or B.S., to teach courses in mechanics and electricity, starting in September. Salary scale good, commensurate with qualifications. Moving expenses paid. Liberal vacation. Opportunity for advancement. Apply to: Head, Department of Mechanics and Electricity, Montana School of Mines, Butte, Montana.

SALES ENGINEER—To represent a large midwest manufacturer of cut gears and speed reducing transmissions on a commission basis in San Francisco, California area and northern part of state. Must have engineering experience and represent allied products. In reply, give full particulars—all replies confidential. Address CA-6483, care of "Mechanical Engineering."

SERVICES AVAILABLE

TRANSLATION, engineering, scientific, by mechanical engineer, P.E. from French, German, Dutch. Free lance. Address CA-6454, care of "Mechanical Engineering."

POSITIONS WANTED

MECH. ENGR., B.S., MIT. and European training, pacifist, 41, single, responsible. U. S. experience: 1 yr. high speed motion picture research; 3 yrs.' power plant thermodynamics; 8 yrs.' turbine and pipe stress analysis; 3 yrs.' engineering college teaching; seeks non-military research, design or teaching. Eastern U. S. preferred. Address CA-6489, care of "Mechanical Engineering."

German College graduated MECHANICAL ENGINEER. Did postgraduate researches on Thermodynamics, Gasdynamics and vibration problems. Held responsible development and consulting engineering positions in turbosuperchargers, piston engines, gas turbine for nuclear applications, aircraft propulsion systems. Seeking new connections. Address CA-6491, care of "Mechanical Engineering."

SALES, MECHANICAL ENGINEER, 31, Registered P.E. New York. 9 years' diversified experience, power plant, chemical, gas and manufacturing industries. Proven record. Desires customer contact position of high responsibility with progressive company. Prefers N.Y.-N.J. headquarters. Nationwide or regional travel not objectionable. Address CA-6478, care of "Mechanical Engineering."

MISCELLANEOUS

REWARD FOR RESEARCH. Will pay $100 to the first person who supplies the name and date of a publication containing a description of a vibratory bowl feeder. The bowl feeder must be for sorting and/or aligning small articles of manufacture such as screws, switch components, etc. and have a spiral track for the articles to be elevated, the misaligned articles to be dropped off the spiral track and the properly aligned articles delivered to an external device. The publication must have an effective date prior to 1944. If more information is desired, please write: Charles L. Lovercheck, ASME Member, 1315 G. Daniel Baldwin Bldg., Erie, Pennsylvania.

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

A non-profit organization
S.E.E. GIVES

To ENGINEERS
Service in providing contacts for choice positions available now. Send resume.
Small Handling charge—No Placement Fee

To EMPLOYERS
Automatic access to a wide variety of desirable talent—now and regularly—from wide geographical locations.

SCIENTISTS, ENGINEERS & EXECUTIVES, Inc.
1026 Seventeenth St., N.W.
Washington 6, D. C. — MEtropolitan 8-2749

SALARIED PERSONNEL $5,000 to $30,000. This nation-wide service successful since 1927 finds openings in your field. Sells your abilities; arranges contacts. Present position protected. Write for details—Jira Thayer Jennings, P. O. Box 674, Manchester, Vermont.

SALARIED POSITIONS—$6,000 to $35,000. We offer the original personal employment service (established 47 years). Procedure of high standards individualized to your personal requirements. Identity covered. Particulars—R. W. Bixby, Inc., 562 Brisbane Bldg., Buffalo 3, N. Y.

PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member ASME and President of Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

Every Advertiser appearing in MECHANICAL ENGINEERING believes . . . . that his products . . . the service in them and the service behind them . . . will stand up under the most searching scrutiny of the high caliber engineers and executives comprising MECHANICAL ENGINEERING readership.

See them Now!

Industry's MOST WANTED line of GENERAL PURPOSE VALVES

FOR PETROLEUM REFINERIES
CHEMICAL PLANTS • POWER PLANTS

Write for Supplement No. 1 to Catalog F-9
Address Dept. 24-AFM

MOST WANTED — that's right — because the G P line includes gate, globe, and angle type valves having seats faced with **HAYNES STELLITE*** alloy or other hard facing alloys for greater seat-wear resistance . . . at no extra cost!

Hard faced seats, in combination with precision finished, selectively hardened discs and wedges give these valves amazing resistance to erosion, corrosion and galling. That's why they are setting new standards of performance in steam, water, oil, or gas services at the recommended pressures and temperatures.

Get longer, drop-tight, service life with minimum maintenance by specifying Vogt G P Valves. Available in a complete range of sizes from ¼" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

HENRY VOGT MACHINE CO.
P. O. Box 1918—Louisville 1, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati.

Vogt — GENERAL GP PURPOSE — Vogt FOR BETTER VALVES

DROP FORGED STEEL
VALVES

*Trade-Mark of Union Carbide and Carbon Corporation

CONSULTING SERVICE

Manufacturers of Equipment not included

RATES: One-inch card announcements inserted at rate of $25 each issue, $20 per issue on yearly contract

AMERICAN NUCLEAR DESIGN COMPANY
NUCLEAR ENGINEERING
Nuclear Design and Evaluation
Product Development
Radiation and Hazards Studies
1025 Connecticut Avenue, N.W.
Washington 6, D. C. District 7-1161

JACKSON & MORELAND, INC.
Engineers and Consultants
Design and Supervision of Construction
Reports—Examinations—Appraisals
Machine Design—Technical Publications
BOSTON NEW YORK

Consult **Z. H. POLACHEK**
REG. PATENT ATTORNEY
1234 Broadway
(at 31 St.) New York 1, N. Y.
Phone LO-5-3088

BLACK & VEATCH
CONSULTING ENGINEERS
Electricity—Water—Sewage—Industry
Reports, Designs, Supervision of Construction
Investigations, Valuation and Rates
1500 Meadow Lake Parkway, Kansas City 14, Mo.

M. W. KELLOGG
Piping System Flexibility Analyses
Unique model tester as well as modern digital computer facilities available for low cost, accurate flexibility analyses of the most complex piping systems.
The M. W. Kellogg Company
711 Third Avenue, New York 17, N. Y.

SANDERSON & PORTER
CONSTRUCTION
REPORTS SURVEYS
New York New York

H. LESLIE BULLOCK, P. E.
Non-specialist
Engineer & Consultant
Co-ordinator and interpretor of inter-departmental problems; safety surveys and recommendations, process investigations.
136 Liberty Street, New York 6, N. Y.

The Kuljian Corporation
ENGINEERS • CONSTRUCTORS • CONSULTANTS
POWER PLANT SPECIALISTS
(Steam, Hydro, Diesel)
UTILITY • INDUSTRIAL • CHEMICAL
1200 N BROAD ST., PHILA. 21, PA.

Power Plants, Structures
Transmission Systems
Design, Supervision, Inspection
Appraisals, Reports
SARGENT & LUNDY
140 S. Dearborn St., Chicago, Ill.

ELECTRICAL TESTING LABORATORIES, INC.
2 East End Avenue, New York 21, N. Y.
Electrical, Electronic, Environmental, Photometric and Chemical Laboratories.
Testing, Research, Inspection and Certification

PETER F. LOFTUS CORPORATION
Design and Consulting Engineers
Electrical • Mechanical
Structural • Civil
Nuclear • Architectural
ESTABLISHED 1923
FIRST NATIONAL BANK BUILDING
Pittsburgh 22, Pennsylvania

J. C. SOMERS, P. E.
INDUSTRIAL ENGINEERING—planning, controls, measurement, training, methods, cost estimates, plant and facility engineering.
INDUSTRIAL DEVELOPMENT—surveys, reports, plant selection, product or plant lists, industrialization, programs, estimates.
31-48 78 St. Jackson Heights, N. Y., N. Y.,
RAvenswood 9-2615

GILBERT ASSOCIATES, INC.
Engineers and Consultants
Design and Supervision of Construction
Mechanical • Electrical • Structural
Sanitary • Chemical Laboratory
Business and Economic Research
New York **READING, PA.** Washington

WELD TESTING
Qualification of Operators—Supervision
Inspection—Research
NATIONAL WELD TESTING BUREAU
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

STANLEY ENGINEERING COMPANY
Consulting Engineers
Hershey Building
Muscatine, Ia.
208 S. LaSalle Street
Chicago 4, Illinois

HARZA ENGINEERING COMPANY
CONSULTING ENGINEERS
E. Montiford Fucik Calvin V. Davis
Richard D. Harza
Hydroelectric Plants and Dams
Transmission Lines
Flood Control Irrigation
River Basin Development
400 West Madison Street Chicago 6

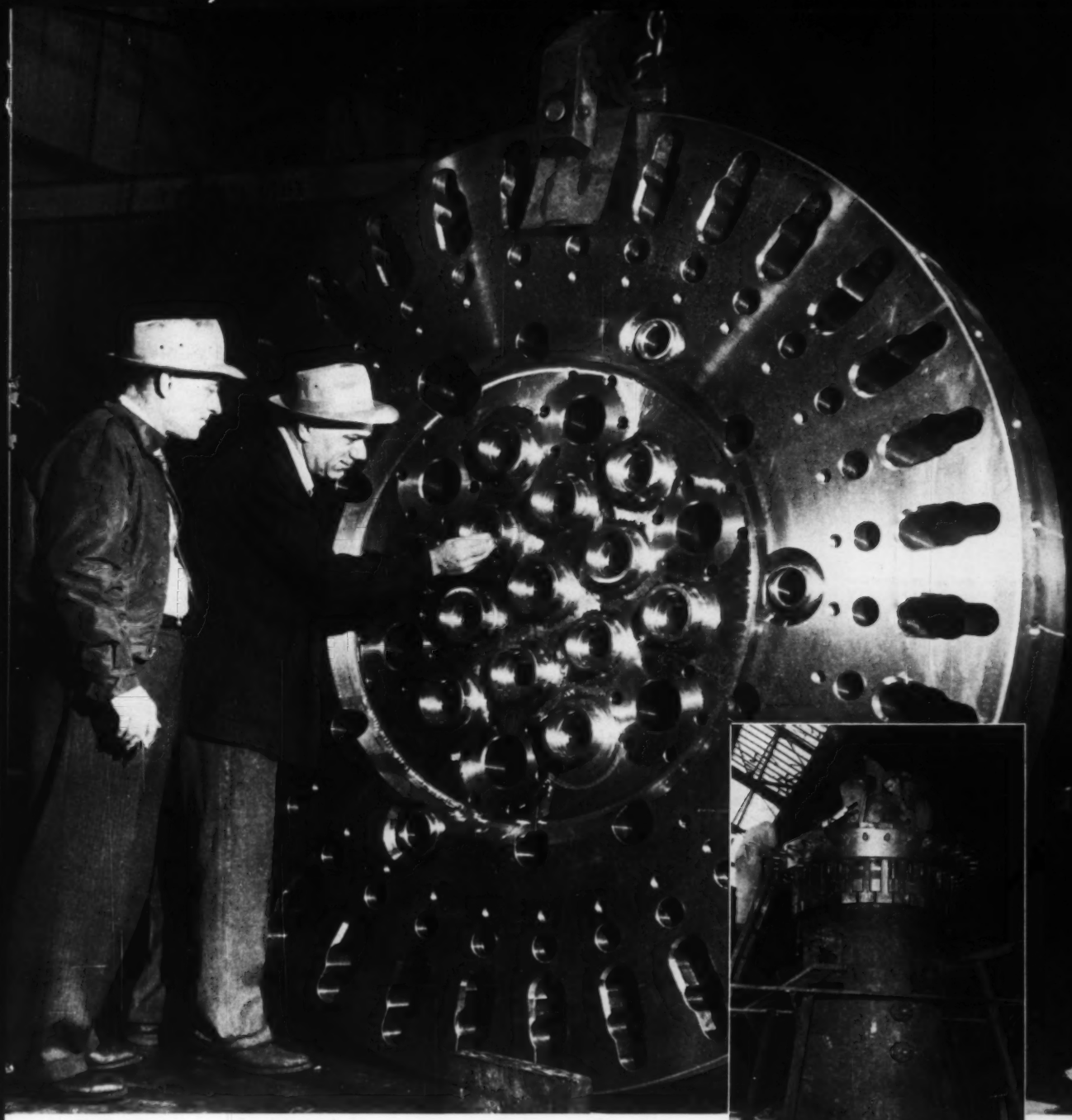
PROPANE GAS PLANTS
and
Anhydrous Ammonia Plants
PEACOCK CORPORATION
Box 268, Westfield, N. J. Adams 2-6258

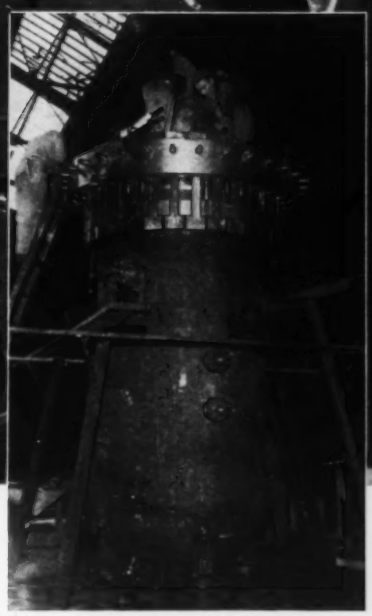
SVERDRUP & PARCEL, INC.
Engineers—Architects
Design • Construction Supervision
Steam and Hydroelectric Power Plants
Power Systems • Industrial Plants
Studies • Reports
San Francisco ST. LOUIS Washington

The above consultants are available

to work out solutions

to your engineering and management problems.





This pressure vessel had to be designed with a closure that would open in 30 minutes, and withstand 1500 psi, 550F. Made of Type 304 stainless, the top head has 34 connections, of which 19 required exceptionally close tolerances for control rods.

FOR NUCLEAR NEEDS of Knolls Atomic Power Laboratory, M. W. Kellogg was given the exacting assignment of designing and producing a 32½-ton "Proof Test Reactor Pressure Vessel". This was an unusually complex task, because of the quick-opening closure specifications, requiring a head with novel design and extremely close tolerance machining.

FOR NUCLEAR NEEDS of others, Kellogg is supplying the primary coolant stainless piping for two nuclear plants. In addition, Kellogg is equipped to engineer and manufacture heat exchanger equipment for nuclear energy power plants. If these specialized skills suggest a solution to *your* nuclear problems, call Kellogg's Fabricated Products Sales Division.

THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Limited, Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

M KELLOGG W

INDEX TO ADVERTISERS

Acme Chain Corp. 165
*Adsco Div., Yuba Consolidated Industries (Inc.) 34
*Aerovent Fan Co. 229
*Air Preheater Corp. 223
Ajax Flexible Coupling Co. 180
*Allegheny Ludlum Steel Corp. 206
Allen-Bradley Co. 201, 202
*American Blower Div., American-Standard 208
*American Brass Co. 197
American Cast Iron Pipe Co. 28
*American Pulverizer Co. 176
ASME Publications 224, 225
Mechanical Catalog 176
Annin Co. 29
*Armstrong Machine Works 49
Atomics International Div., North American Aviation (Inc.) 214

*B-L-H, Lowey-Hydropress Div. 207
*Babcock & Wilcox Co. Boiler Div. 2nd Cover
Tubular Products Div. 4
*Bailey Meter Co. 218
Barco Mfg. Co. 243
Bell Telephone Laboratories 2
Bituminous Coal Institute 46, 47
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. 173
*Buffalo Forge Co. 203
Bundy Tubing Co. 45
*Bunting Brass & Bronze Co. 185
Bushings (Inc.) 229

Chace, W. M., Co. 181
Chance Vought Aircraft (Inc.) 170, 171
Clarage Fan Co. 200
Clearprint Paper Co. 16
Cleveland Worm & Gear Co. 191
*Columbia-Geneva Steel Div. 10, 11
Cone-Drive Gears Div., Michigan Tool Co. 50
Crane Co. 17
Curtis Mfg. Co. 42
Curtiss-Wright Corp. 7

*Detroit Stoker Co. 227
DeZurik Corp. 230
*Diamond Power Specialty Corp. 179
Douglas Aircraft Co. 216
*Dresser Industries (Inc.) 8, 9
Pacific Pumps (Inc.) 33
Duff-Norton Co. 164

Eagle Pencil Co. 51
Edward Valves (Inc.) Sub. Rockwell Mfg. Co. 24, 25

Faber-Castell, A. W. 31
*Fairbanks, Morse & Co. 20, 215
*Falk Corp. 199
Farrel-Birmingham Co. 53
*Flexitallic Gasket Co. 41
Foote Bros. Gear & Machine Corp. 174
*Foxboro Co. 27

Gear Specialties (Inc.) 6
General Atomic Div. General Dynamics Corp. 238
General Electric Co. 233
General Radio Co. 22
*Golden-Anderson Valve Spec. Co. 195
*Grinnell Co. 40

Hamilton Mfg. Co. 163
Heim Co. 244
*Homestead Valve Mfg. Co. 21
Hydrokranbau-Gesellschaft Wiese & Co. 236

*Ingersoll-Rand Co. 48
International Business Machines 236
International Nickel Co. 54

*James, D. O., Gear Mfg. Co. 192
Jeffrey Mfg. Co. 210
Jenkins Bros. 160
Jet Propulsion Laboratory Div. of Calif. Institute of Tech. 182

Kellogg, M. W., Co. 241
Koh-I-Noor Pencil Co. 194
Koppers Co. Fast's Coupling Dept. 32

Little, Arthur D. (Inc.) 233
Lockheed Missile Systems 235
*Lowey-Hydropress Div., B-L-H 207

McDonnell & Miller (Inc.) 192
Marquardt Aircraft Co. 168, 169
Marsh Instrument Co. Affil. James P. Marsh Corp. 222
Maryland Shipbuilding & Drydock Co. 205
Melpar (Inc.) Sub. Westinghouse Air Brake Co. 172
*Mercoid Corp. 188
Metcalf & Eddy 236

National Advisory Committee for Aeronautics 204
National Airoil Burner Co. 193
National Exposition of Power & Mechanical Engineering 221
New Departure Div., General Motors Corp. 1
*New York Blower Co. 177
Nice Ball Bearing Co. 230
Nordberg Mfg. Co. 44

OPW Corp. Jordan Industrial Sales Div. 188
Ohio Injector Co. 3rd Cover
Ozalid Div., General Aniline & Film Corp. 39

*Pacific Pumps (Inc.) Div. Dresser Industries (Inc.) 33
*Pangborn Corp. 213
Pantex Mfg. Corp. 193
*Philadelphia Gear Corp. 232
Pittsburgh Lectrodryer Div., McGraw-Edison Co. 217
Pittsburgh Piping & Equipment Co. 52

Raytheon Mfg. Co. 186
Rhopac (Inc.) 196
Robertshaw-Fulton Controls Co. Bridgeport Thermostat Div. 173
Rockford Clutch Div., Borg-Warner 178
Rust-Oleum Corp. 18, 19

Sandia Corp. 198
*Sandusky Foundry & Machine Co. 36
Shell Oil Co. 43
Snap-Tite (Inc.) 159
*Southwest Products Co. 231
Spraying Systems Co. 196
Stephens-Adamson Mfg. Co. 219
*Struthers Wells Corp. Div. Titusville Iron Works 189
Sylvania Electrical Products (Inc.) 234

Taylor Instrument Cos. 226
*Tennessee Coal & Iron Div. 10, 11
*Terry Steam Turbine Co. 30
Texas Instruments (Inc.) 237
Thomas Flexible Coupling Co. 190
Timken Roller Bearing Co. 4th Cover
*Titusville Iron Works, Div. of Struthers Wells Corp. 189
*Tube Turns 211, 212

United States Pipe & Foundry Co. 14, 15
*United States Steel Corp. 10, 11
*United States Steel Export Co. 10, 11

*Virginia Gear & Machine Corp. 232
Vitro Laboratories Vitro Corp. of America 162
*Vogt, Henry, Machine Co. 239
*Voss, J. H. H., Co. 231

Walworth Co. 35
West Virginia Pulp & Paper Co. 234
Western Gear Corp. 157
Westinghouse Electric Corp. 166, 167, 220
Sturtevant Div. 23
*Wheeler, C. H., Mfg. Co. 209
*Wickes Boiler Co. Div. Wickes Corp. 12, 13
Wiley, John & Sons 175
Winsmith (Inc.) 187
Wollensak Optical Co. 231
*Worthington Corp. 37, 38

*Yarnall-Waring Co. 155
Yoder Co. 190
*Yuba Heat Transfer Div., Yuba Consolidated Industries (Inc.) 26

* The asterisk indicates that firm has product catalog in the 1958 Mechanical Catalog.

Your attention is directed to

Keep Informed 161–196
Consulting Service 240
Opportunities 233–238

Advertisers appearing in previous 1958 issues

*Aldrich Pump Co.
All American Tool & Mfg. Co.
*Aluminum Co. of America
Anker-Holth Div.,
Wellman Engineering Co.
Arcos Corp.
*Associated Spring Corp.
Aurora Pump Div.,
New York Air Brake Co.

*Babcock & Wilcox Co.
Tubular Products, Fittings Dept.
*Badger Mfg. Co.
Best, Richard, Pencil Co.
*Blaw-Knox Co.
Power Piping & Sprinkler Div.
Bonney Forge & Tool Works
*Boston Gear Works
Brown Boveri Corp.
*Buffalo Pumps (Inc.)
Div. Buffalo Forge Co.
Byers, A. M., Co.

C.E.M. Co.
*Cash, A. W., Co.
*Chicago Bridge & Iron Co.
Cincinnati Gear Co.
Circle Seal Products Co.
*Clark Brothers Co.
Dresser Industries (Inc.)
*Combustion Engineering (Inc.)
*Consolidated Chimney Co.
Crane Packing Co.

Davis Engineering Corp.
Denison Engineering Div.,
American Brake Shoe Co.
Diamond Chain Co. (Inc.)
Dudek & Bock Spring Mfg. Co.

Ellison Draft Gage Co.
*Erie City Iron Works

Faber, Eberhard, Pencil Co.
Farval Corp.
*Flexonics Corp.
*Foster Wheeler Corp.
Frick Co.
Funk Mfg. Co.

Garfield, Oliver, Co.
Goshen Rubber Co.
*Green Fuel Economizer Co.

Hagan Chemicals & Controls (Inc.
Houdaille Industries (Inc.)
Buffalo Hydraulics Div.
Manzel Div.
*Hyatt Bearings Div.,
General Motors Corp.

*Illinois Gear & Machine Co.
Imperial Tracing Cloth
Industrial Vinyls (Inc.)

Keuffel & Esser Co.
Koppers Co.
Piston Ring & Seal Dept.

*Ladish Co.
Lefax Publishers
Lenape Hydraulic Pressing & Forging Co.
*Link-Belt Co.
Lunkenheimer Co.

MB Mfg. Co.
Merriman Brothers (Inc.)
*Metallo Gasket Co.
*Midwest Piping Co.
Miehle-Dexter Supercharger Div.,
Christensen Machine Co.
Miller Valve Co.

Nagle Pumps (Inc.)
National Dust Collector Corp.
Niagara Blower Co.
*Northern Blower Co.
Nugent, Wm. W. & Co.

*Oilgear Co.
Oldsmobile Div.,
General Motors Corp.

*Patterson Kelley Co.
Perfection Gear Co.
American Stock Gear Div.
*Posey Iron Works
Powell, William, Co.
Precision Rubber Products Corp.

Raybestos Manhattan (Inc.)
Manhattan Rubber Div.
Packing Div.
Reliance Gauge Column Co.
*Republic Flow Meters Co.
Sub. Rockwell Mfg. Co.
Ric-Wil (Inc.)
Ronald Press Co.
*Roots-Connersville Blower Div.
Dresser Industries (Inc.)

Shenango Furance Co.
Sly, W. W., Mfg. Co.
*Smith, S. Morgan, Co.
Stewart-Warner Corp.
Alemite Div.
Streeter-Amet Co.
Sturtevant, P. A., Co.
*Syntron Co.

*Taylor Forge & Pipe Works
Technical Charts (Inc.)

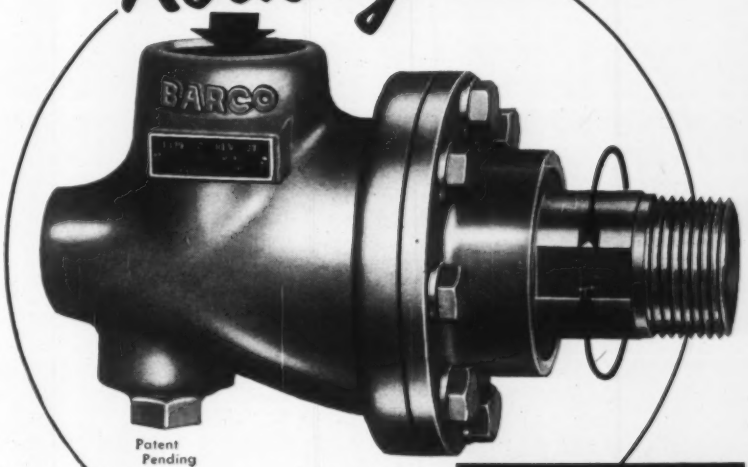
*Union Iron Works
*United States Graphite Co.
Div. Wickes Corp.
Universal Drafting Machine Corp.

Vickers (Inc.)
Div. Sperry Rand Corp.

Wabash Metal Products Co.
Wiegand, Edwin L., Co.
Williams Gauge Co.
Worcester Valve Co.

*Zallea Brothers
Zonolite Co.
Z-Crete Div.

NOW-A Better Rotary Joint!



Patent Pending

SIZES
½" ¾" 1" 1¼"
1½" 2" 2½" 3"

NEW BARCO TYPE C Rotary Joint

"SUPER" Performance and Construction —at no extra cost!

"CRACK-FREE" CHROME PLATED SLEEVE—A standard Barco feature. "Crack-free" chrome on rotating sleeve minimizes corrosion, friction, wear. Stainless steel spring also standard.

RESISTS SEAL RING BREAKAGE—The spherical seal ring is under compression, not *tension*, loading. Seal withstands shock loads and alternating hot and cold service.

NO LUBRICATION NEEDED—Spherical seating seal self-adjusting for wear.

WIDE SPACED BEARINGS—Two, instead of one . . . increased bearing area.

200 P. S. I. STEAM RATING—Heavy duty service at *no extra cost*. Lowest friction. Hydraulic loads to 400 psi; temperatures to 450°F, special to 500°F.

FOR ALL SERVICES—One basic style of joint for single flow or syphon flow . . . one basic seal for all services. AVAILABLE NOW.

for

STEAM
WATER
OIL
AIR or GAS

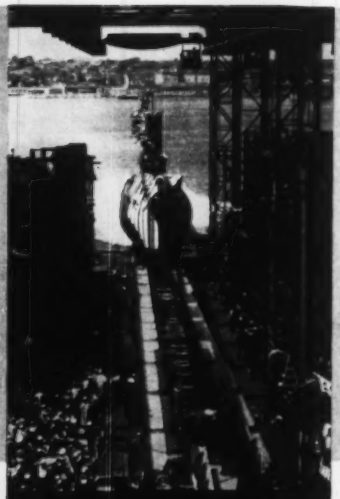
SEND FOR NEW CATALOG 310 TODAY.

PRODUCTS BACKED BY EXPERIENCE
BARCO
ANNIVERSARY
1908 50TH 1958

BARCO MANUFACTURING CO.
5216 Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
In Canada: The Holden Co., Ltd., Montreal

How... HEIM *Unibal*® SPHERICAL BEARING ROD ENDS ....ARE USED IN THE... U.S.S. SKATE

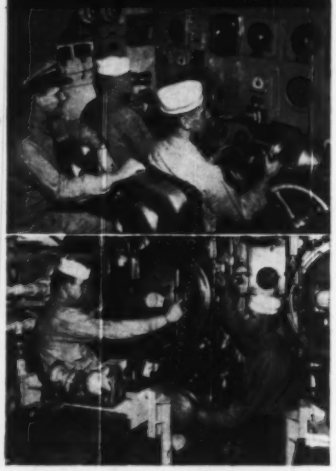


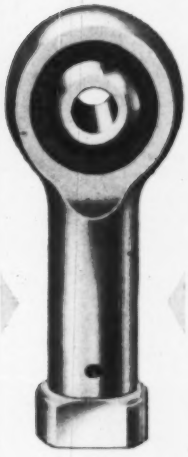
Launched in May, the atomic submarine, Skate, started its builder's trials in November, and in March, made a record crossing to Europe. Built by General Dynamics Corporation's Electric Boat Division of Groton, Conn., it is our third underwater craft to be powered through the use of nuclear fission.

FROM THE CONTROL ROOM, AIRPLANE TYPE "JOYSTICK CONTROLS" GUIDE THE ATOMIC SUBMARINE

Heim Unibal Rod Ends are used here and in the linkages and mechanisms which operate:—

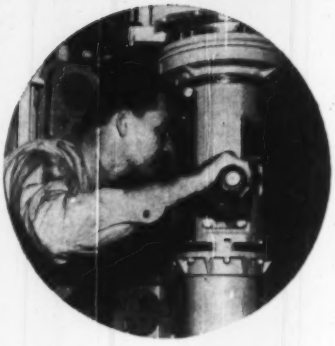
- **The steering and diving gear follow-up xmitter.**
- **Emergency diving control valve.**
- **Stern diving gear.**
- **Steering emergency control valve.**
- **Stern diving gear, follow-up and transmitter drive.**





HEIM
ROD END

The "Guns" of an atomic submarine are its torpedo tubes. Heim Unibal Rod Ends are used here in the torpedo handling gear.



Surface coordinates are checked through the submarine's periscope. All equipment aboard is powered by energy generated from Skate's water-cooled reactor system.

Keeping pace with technological advances, Heim Unibal bearings meet those exacting specifications so vital to the operation of Uncle Sam's fleet of atomic underwater craft. It is reasonable to assume that you do not have the plans for a nuclear-powered submarine on your drawing board at the moment, but, . . . If your product employs a push-pull motion, if power is transmitted at changing angles through linkages of one kind or another, or if the correction of misalignment is a requirement, we know that . . .

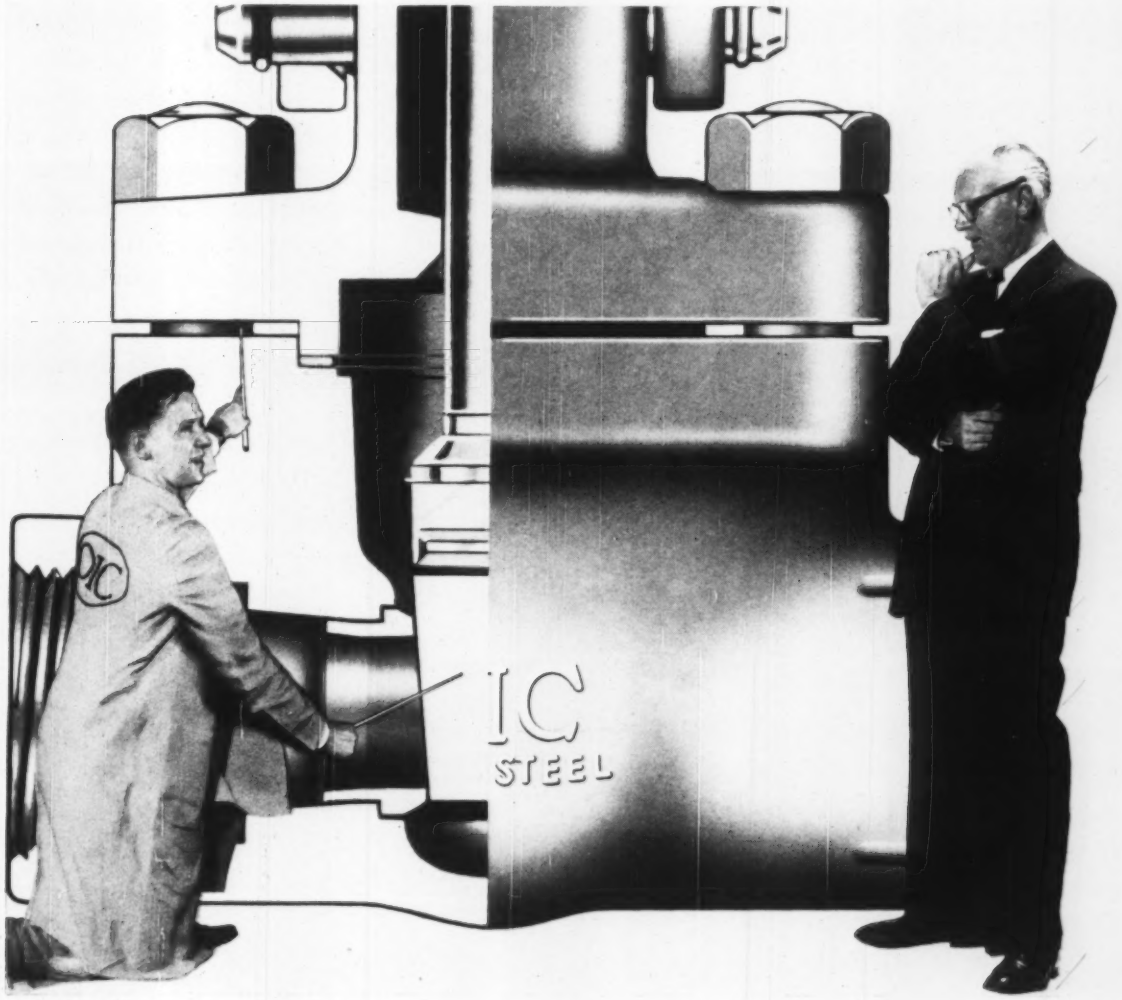
HEIM Unibal® Spherical Bearings

. . . can do all this better and for less money. Unibal is the original plain, spherical bearing developed, engineered, and manufactured by Heim for over fifteen years.

Write for catalog showing sizes, load ratings, and complete list of stock bearings. Ask for engineering help on your more intricate problems.

THE HEIM COMPANY FAIRFIELD, CONNECTICUT

...and you can see here....and here, sir, how we've killed maintenance problems on our new forged steel lines.



We stop galling and erosion by giving you 13% chrome stainless steel trim with wedges *duracased* to a rugged *1000 Brinell hardness.*

The square and *bolted* body-bonnet joint makes it easy to service the valve quicker. And it's a tighter joint, made doubly leakproof by recessing the soft iron gasket into the body. The gasket can't blow!

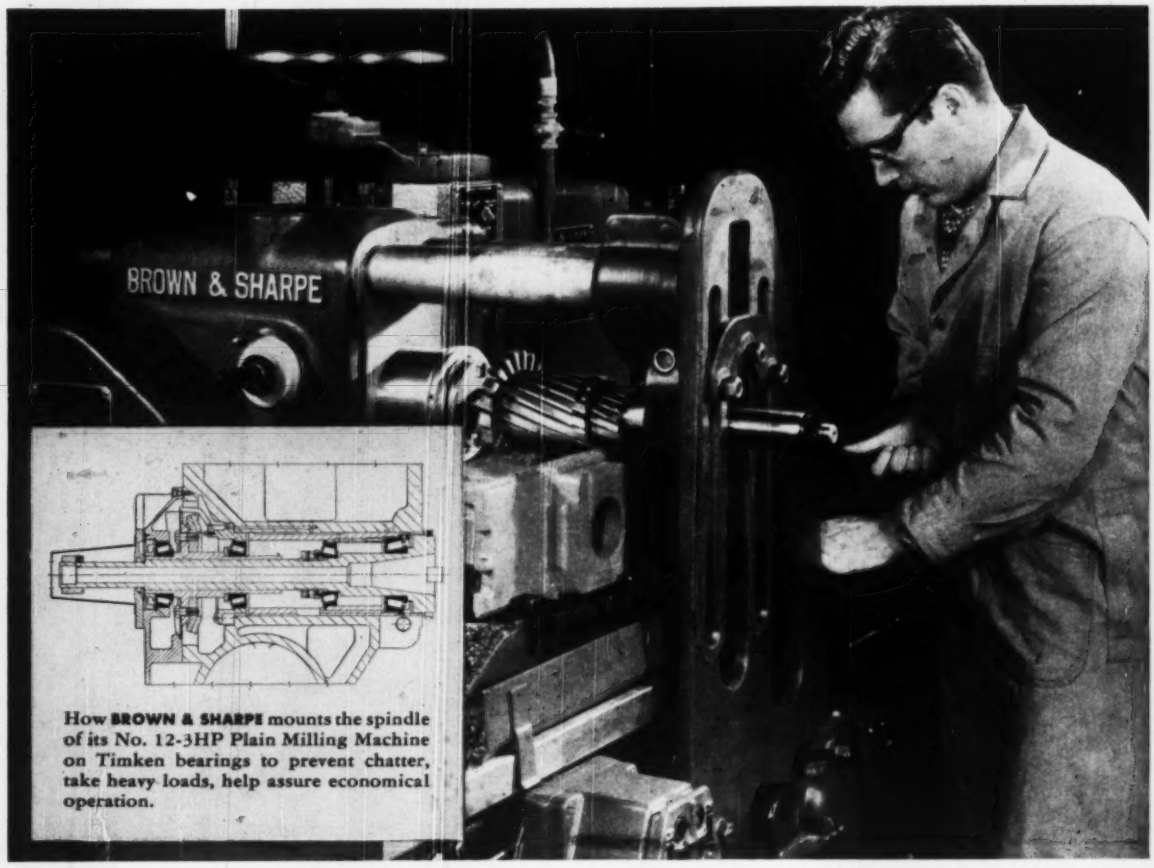
And you get the fastest joint make-up you've ever seen. Look at those pipe ends. See the extra wrench-gripping area and lugs. See how body-bonnet flanges are out of the wrench's way. No time lost here!

These new 600-lb. OIC forged steel valves are available with either *high-flow* ports (1300 line), or *standard-flow* ports (1100 line). Call your OIC Distributor, or write for specification literature.

The Ohio Injector Company • Wadsworth, Ohio

OIC **VALVES**

BRONZE, IRON, FORGED AND CAST STEEL, LUBRICATED PLUG VALVES



How **BROWN & SHARPE** mounts the spindle of its No. 12-3HP Plain Milling Machine on Timken bearings to prevent chatter, take heavy loads, help assure economical operation.

Climb mills both ways . . . TIMKEN® bearings prevent chatter in heavy cutting

TO make heavy cuts without chatter, Brown & Sharpe mounts the spindle of its No. 12-3HP Plain Milling Machine on two Timken® tapered roller bearings. For smooth power transmission, they use four Timken bearings in the bevel gear drive to the spindle. And to take climb milling's pulsating loads, two Timken bearings are used in the feed screw drive. Result—production milling is fast and accurate. Here's why.

• SPINDLE RIGIDITY MAINTAINED

Timken bearings hold the spindle in positive alignment. Their tapered design lets them take *both* radial and thrust loads in any combination. And full line contact between rollers and races gives Timken bearings extra load-carrying capacity.

• HEAVY LOADS ABSORBED

Rollers and races on Timken bearings are case-carburized to have a hard, wear-resistant surface over a tough, shock-resistant core. They take heavy loads and come back for more.

• FRICTION VIRTUALLY ELIMINATED

Timken bearings are geometrically designed to have true rolling motion and are precision-made to live up to their design. Practically friction-free, they last longer and run smoother. And to assure complete quality control, we even make our own electric furnace fine alloy steel. No other American bearing maker does. So for your No. 1 bearing value, always specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD